A CONSTRUCTION SUPERINTENDENT'S PROJECT MONITORING SYSTEM

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A Construction Superintendent's Project Monitoring System

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ABSTRACT

Computerized methods have not been widely accepted by the construction industry with regard to project cost control and scheduling. As computer technology advances and the economic pressures on contractors increase, it will become apparent that a unified management information system will be needed to adequately control a large to medium size construction company. A project monitoring system is developed which applies management information theory to the practical problem of providing a construction Superintendent with a usable computerized schedule.

Formats are shown for the proposed computer reports and forms are presented which indicate the method of gathering data on a daily and weekly basis. Simulated input and output reports are developed, but no computer programs are included.

Conclusions are drawn from a survey of building construction firms and the computer reports reflect these conclusions. The feasibility of the proposed monitoring system is discussed, and it is concluded that medium sized construction firms would benefit most from the system.

KEY WORDS

Project Management, Construction Superintendent, Critical Path, Scheduling, Management Information System, Cost Control.

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DEFINITION OF TERMS

ACTIVITY - A segment of a project representing a specific amount of work to be accomplished and having definite points in time of beginning and ending.

ACTIVITY-ITEM - A detailed portion of an ACTIVITY indicating labor, material, and equipment requirements to accomplish the segment of the work.

BAR CHART - A chart with a horizontal time scale on which ACTIVITIES are shown by a series of "V's" plotted to indicate the start and end of an ACTIVITY.

CPM - Critical Path Method of scheduling is an analytical computational technique utilizing a work logic network diagram to determine the timing of each ACTIVITY in the project.

CHANGES - Conditions which cause a revision in the work schedule. They can be classified as expected and unexpected. Expected changes come from owner or contractor initiated modifications to the plans, while unexpected changes result from weather conditions and material delays

DUMMY ACTIVITY - An ACTIVITY with a duration of zero which is used to indicate the logic sequence of the work. Since no two ACTIVITIES can have the same "I-J number," a Dummy Activity is used to allow parallel work sequences.

FIELD REPORTS - Those reports sent to the Superintendent for his use in controlling the project.

I and J - Symbols designating the starting point and finishing point of

I and J - (Continued) each ACTIVITY. Each ACTIVITY has a unique "I - J Number" which identifies it.

INPUT - Data which are entered into the computer for processing.

KEYED - Certain INPUT data is matched internally by the computer with information previously stored. For example, ACTIVITY-ITEM numbers are "keyed" to cost account numbers by the computer.

MILESTONES - Any specifically defined point in time with respect to the project. Usually, it is a major event in the project such as completion of the exterior walls, or delivery of an important piece of equipment.

MIS - Management Information System is a concept of unifying business decisions with a computer based data processing system.

NONROUTINE DATA - Data which is not normally processed by the personnel preparing the INPUT reports.

OUTPUT - Material produced by the computer which results from processing the INPUT data.

ROUTINE DATA - Data which is normally processed by the personnel preparing the INPUT reports.

SLACK - The difference between the latest possible starting time and the earliest possible starting time of an ACTIVITY. Negative values indicate the project is behind schedule.

DEFINITION OF TERMS (Continued)

SOFTWARE - Computer programs designed to operate on a specific computer system capable of producing predetermined reports, or manipulating the data.

SPMS - Superintendent's Project Monitoring System for construction projects.

SUPERINTENDENT - Representative of the general contractor who is responsible for the onsite supervision of both the general contractor's work force and the coordination of the subcontractor's work effort.

I. INTRODUCTION

Background

Critical Path Methods (CPM) of scheduling were developed in 1957 by a group from Remington Rand UNIVAC Division of Sperry Rand Corporation who were working with the E. I. duPont de Nemours Company in an attempt to create an improved method of controlling construction cost and time for chemical processing plants (19). Initially, CPM was received enthusiastically by the technical and trade publications as a powerful new tool in construction management. From a simple diagraming technique, CPM was drawn into the field of computerization at a time when computers were relatively primitive. The increased complexity of construction projects helped to accelerate the shift to computers. The end result was a disillusionment of the early users of CPM, because the computer was not able to provide adequate services for the dynamic construction process. In the past 19 years since CPM was first introduced many innovations have been added to this technique, such as resource leveling and cash flow analysis. Computer technology has also improved dramatically to the point where the user's imagination is the limiting factor and not the capability of computer hardware. The time is ripe to develop a comprehensive CPM system which utilizes the best features of the existing systems to form a scheduling and cost control monitoring system which will benefit the contractor.

Objective of Thesis

The objective of this thesis is to define a computer operated scheduling and cost control system which can be used by onsite construction Superintendents. Two key functions of the proposed construction monitoring system will be to provide an easily read and understood

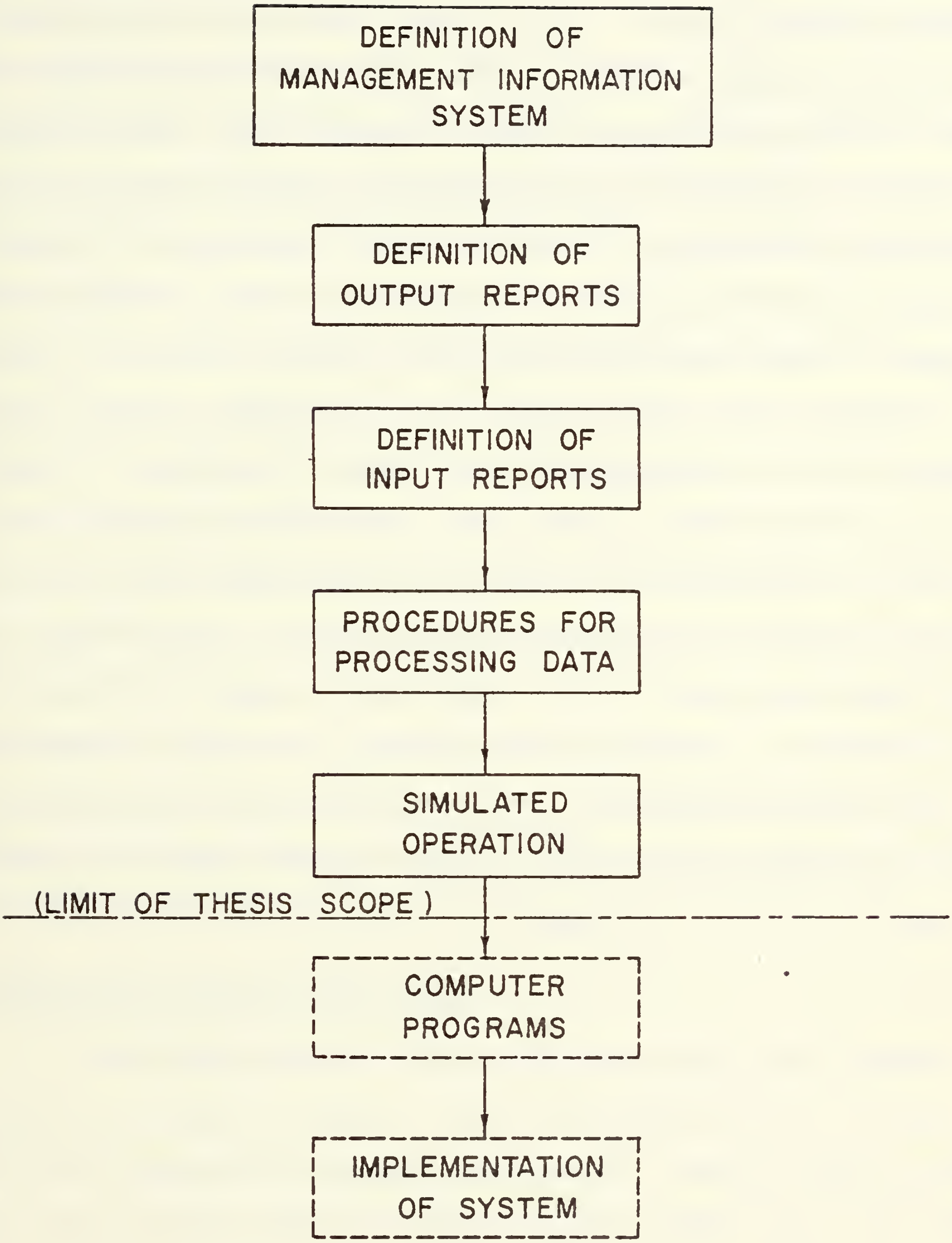
computerized field report, and secondly, to unify the cost accounting system with the scheduling system. In order to substantiate the feasibility of the proposed monitoring system, a simulated operation of the input and output reports will be presented.

Scope and Limitations of Thesis

Figure 1 shows a flow chart which depicts the development of a Construction Superintendent's Project Monitoring System starting with the creation of a management information system and finishing with the field implementation of an operational system. No attempt will be made to develop the computer programs which would produce the specified output reports, since that is not within the scope of this thesis. A detailed presentation will be made regarding procedures for processing data, and reporting forms required to support the computer system. The formats of the computerized output reports will be discussed and sample report forms with explanations of the calculations will be included.

Overall Organization of Thesis

The text of this thesis is divided into six sections with a comprehensive Appendix. The first section is concerned with defining the thesis and justifying the need to examine this topic. The second section deals with the application of a Management Information System (MIS) to a construction company. This business technique is explored with regard to the costs and benefits which a contractor would incur. A brief discussion is presented related to the resource needs of a MIS. The next section provides a detailed description of the proposed project monitoring system with an explanation of the various items in the computer printed reports. The proposed system is then related to the present state of computer



FLOW CHART FOR DEVELOPING A CONSTRUCTION SUPERINTENDENT'S PROJECT MONITORING SYSTEM

FIGURE 1

technology and to the capabilities of a MIS. The fourth section presents the supporting input forms and procedures which are needed to maintain the proposed system. Daily and weekly reports are identified which are submitted by the Superintendent, Purchasing Agent, and the Engineer. A simulated operation of the proposed system is described in section five. Consideration is given to updating the schedule and also to problems which might arise. For analysis purposes, the proposed monitoring system is compared with a "typical" scheduling and cost control system. This "typical" system is a composite of several manual systems taken from the literature. In the last section of the text, conclusions are drawn concerning the feasibility of the proposed monitoring system, and recommendations are made for further study. This future work is concerned with additional surveys of construction companies, and creation of the software and hardware package needed to generate the required monitoring reports. In addition to the various input forms and output formats, the Appendix contains the results of a survey conducted among the large building contractors in the United States concerning their use of computerized scheduling systems.

Rationale for Selecting Thesis Topic

This thesis topic was chosen because the author had witnessed attempts by an owner to impose a Critical Path Method (CPM) of scheduling on the contractors doing work for the owner. Standard computer reports were used with data sorted according to Activity Number; Early Start Date; Early Finish Date; Late Start Date; Late Finish Date; and Total Slack. A non-timescaled CPM Network Diagram was also required. After several years it became obvious that neither the contractor's, nor owner's field personnel really understood, or used the monthly computer reports. This situation served to highlight the need for a field report which would

provide the information required by the field staff of both the owner and the contractor. An easily read report in an understandable form appeared to be the key issue in gaining acceptance of the computer schedule in the field. This same theme has appeared in recent literature in terms of basic research goals for construction management, job satisfaction factors, and determinates of project success. Computer technology has progressed to the point where many sophisticated analytical tools are available to process project schedule information, but there is a communication barrier between the people who design the systems and the people who use the systems. Computers must be used in more innovative ways to provide meaningful information for the non-technical human beings who must implement the schedule (18). A recent survey of construction personnel showed that the Project Superintendents derived a sense of satisfaction on jobs where they were provided with reliable schedule information (2). This point reinforces the premise that good scheduling techniques will result in increased acceptance of the schedule. If the Superintendent is satisfied with the schedule then he will be more inclined to use it. A related survey of large construction companies revealed some interesting trends with regard to successful and unsuccessful users of CPM scheduling (6). The successful users obtained the Superintendent's support and use of the schedule system, while the unsuccessful users did not. A very detailed survey was undertaken by Murphy in 1974 to analyze the determinates of project success (16). While his survey included non-construction contracts the bulk of the respondents were involved in construction. Many factors were found to have a bearing on the success of a project, but it is significant to note that planning and control techniques were related to success when they were adequate, and were related to failure when they

were inadequate.

As previously mentioned, computer scheduling systems have had a tendency to be computer oriented or at best, geared for the engineer in the contractor's home office. This has left the non-technical Superintendent who actually builds the structure with no apparent support from the computer, since he does not understand the computer. In addition to the normal cost account reports, the Superintendent is required to submit update data for the computer. Often the computerized schedule systems increase the Superintendent's paperwork burden without directly assisting his work effort. This forms a built-in reason for the Superintendent to try to subvert the system so he won't have to use it. Appendix A contains the results of a survey of large construction companies. This survey showed a strong correlation between the Project Superintendent's input to the work logic diagram and use of the CPM schedule system to the success of the system. With all of these studies pointing to the need for better methods of producing computer generated project schedules, it is obvious that this subject is worthy of further study.

Research Methods

A brief description of the research methods used in gathering information for this thesis would be helpful in understanding the basis for the material which will be presented later. In order to obtain specific information on present use of CPM scheduling and its success, a survey was initiated among the large building contractors in the United States. Appendix A gives the survey conclusions and Appendix B contains the questionnaires and the summary data which were gathered. Samples of computerized schedule reports were obtained from contractors, owners, and computer vendors. These were analyzed for form and content. Current literature was searched

for both MIS and CPM information, with most of the references coming from journals and magazines. Several contractors were interviewed with the intention of determining how their CPM scheduling system was formulated and how it was functioning (8, 10, 13, 14, 22).

II. MANAGEMENT INFORMATION SYSTEM FOR CONTRACTORS

Management Information Systems

Management information has been in existence for many years. In some instances this information has been systemized into files for storage and retrieval. A typical contractor would probably conceive a management information system to be a series of file cabinets containing financial and construction records with clerks and engineers providing the necessary control reports manually. With the advent of low cost computers and time sharing, this concept is being changed. Under present conditions a more appropriate definition of a Management Information System (MIS) would be as follows (7):

> A Management Information System is an integrated system for providing the information to support the operations, management, and decision making functions of an organization. The system utilizes computer hardware, software, manual procedures, management and decision models, and a data base.

This definition does not imply that the computer is the key element in the system. The human operators are still the most important component with the computer assisting with its ability to accumulate data and process it rapidly. For a contractor, the management models might be a CPM schedule or bidding strategy model. The data base would include all of the pertinent information related to the contractor's operation such as payrolls, accounting, cost estimating, and work scheduling.

Importance of Management Information Systems

The construction industry represents about 10% of the total business volume in the United States, but it accounts for 19% of the business failures. Half of these failures come from firms with less than five years of business practice (20). Since the construction process is a risky operation by nature, it is not surprising that the industry has a high business

failure rate. This would not be a serious problem if construction did not represent the largest single contributor to the United States economy. Rising costs and decreasing margins of profit demand that the contractor exercise tighter control over his bidding and project monitoring operations. Both inaccurate cost estimating data, and ineffective cost and schedule control can result in financial ruin of the contractor. In order to control a modern construction project with its many diverse components such as speciality subcontractors, and staggered material deliveries, it is essential that the contractor maintain a reporting system which keeps him appraised of the status of each phase of the project. In larger companies with several levels of management it is necessary to provide status reports with decreasing levels of detail as the rank of the user increases. This creates a pyramid effect where subordinates are continually generating reports for their superiors to the detriment of their productive duties. A system of simple data collection and rapid data output would facilitate the control requirements for a contractor if the system were to be functional. An equally important reason for contractors to embrace a MIS is the growing trend among owners to require computerized scheduling and cost control. The Federal Government through the General Services Administration and the Defense Department have accepted this philosophy, and so have an increasing number of private owners who utilize construction contractors. With these requirements in mind it is apparent that a MIS can fill a real need in a contractor's operational environment.

Concept of Leverage Points

Like other industries, the construction industry has limited resources of men and money to expend on administrative systems. It is essential that each firm identify the key decisions and control points which

are vital to the company's operation. These basic management operations are called leverage points and they should be supported by the MIS. The term "leverage point" is used because it is meant to represent those specific areas in a firm's management operation which have a large impact on the overall business. Table 1 shows a possible tabulation of management information requirements by functional unit in a construction firm. The items marked with an asterisk are leverage points. Obviously, all of the management decisions cannot be so crucial as to be considered key decisions. Once the scope of the MIS has been restricted to supporting the leverage points, a reasonable allocation of resources can be made for the system. Attempts to capture all information and provide multitudes of reports is self-defeating because extensive resources will be committed to maintaining the MIS and so many reports will be produced that the human elements in the system will be overwhelmed.

Support Requirements for Information Systems

Data needs. In addition to raw data input, a MIS has hardware and software needs for data processing, and personnel requirements for operation of the system. Each of these elements will be discussed in detail because it is important to understand the physical restraints which will be placed on the MIS. The data input needs are specific, but they are easily captured if a unified system of reporting is used. Daily field reports can provide information on manhours worked by employee; material delivered; actual start and finish dates for each phase of the work; equipment utilization, and subcontractor activity. Weekly field reports can supply data regarding the percentage of work-in-place for both the prime and subcontractors. Purchasing status for materials and subcontractors is

TABLE 1

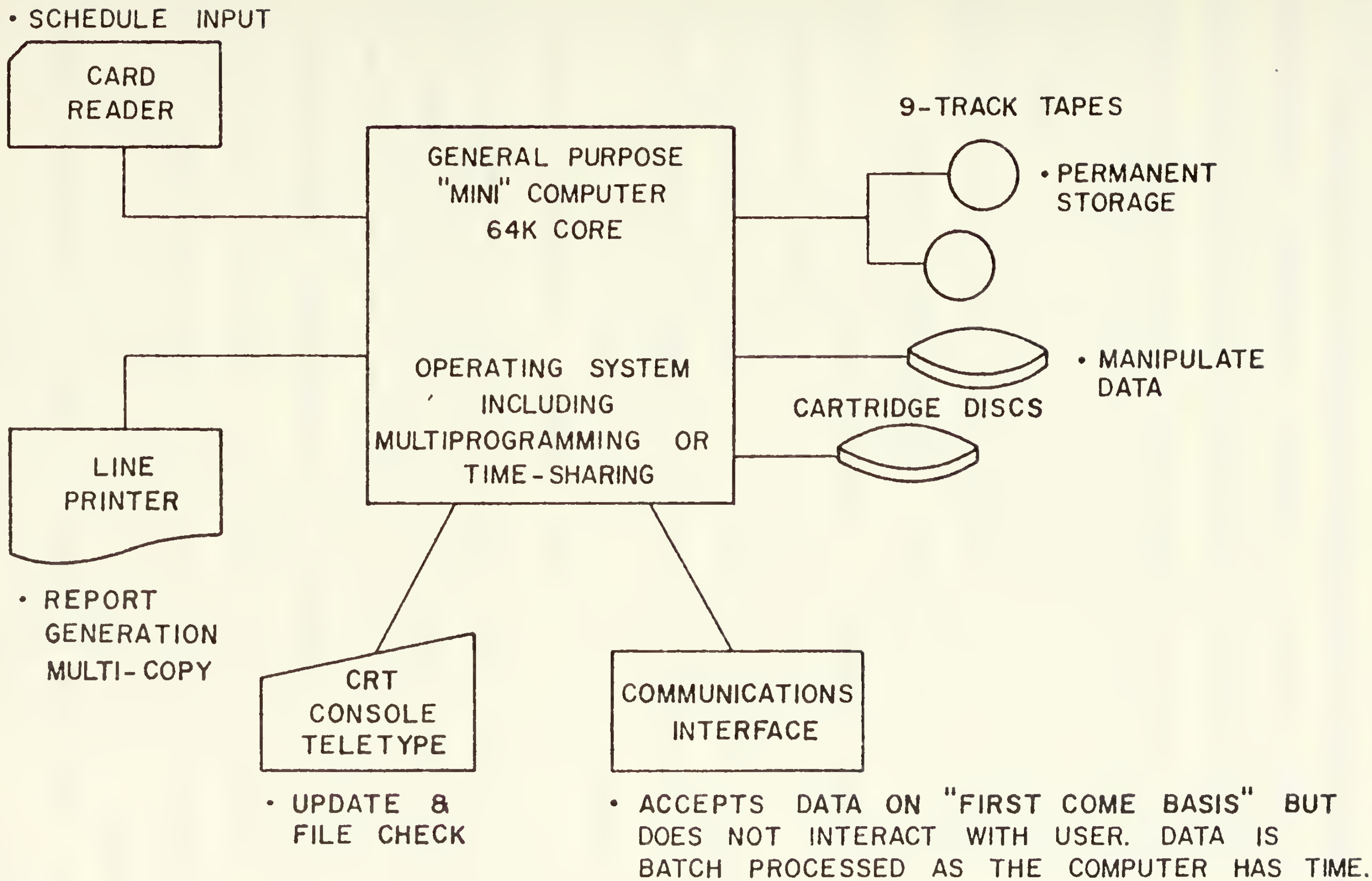
MANAGEMENT DECISIONS BY FUNCTIONAL AREA

MANAGEMENT LEVEL	FUNCTIONAL AREAS					
	Sales	Personnel	Work Scheduling	Finance/ Accounting	Bidding	Purchasing
Strategic	*Total Sales Goal *Type of Work Desired *Pick Large Jobs	·Set Manpower Level ·Staff Tactical	·Division Project Status	·Dividends	*Set Bid (Large)	*Secure Subcontractors (Large)
Tactical	*Pick Medium Jobs ·Projected Work	·Staff Operations	·Branch Project Status	*Investment	*Set Bid (Medium)	*Secure Subcontractors (Medium)
Operational	·Pick Small Jobs ·Customer Assets	*Hire Career Men ·Labor Relations ·Employee Relations	·Project Status	*Project Cost ·Cash Flow ·Asset/ Liability	·Set Bid (Small)	·Secure Subcontractors (Small)
Transactional	·Status of Prospective Work ·Find Work	*Job Assignment ·Safety ·Training	*Job Schedule	·Payroll ·Billing ·Overhead Costs ·Pay Bills	·Cost Estimate ·Unit Cost Accounting ·Bid Model	·Subcontractor Award Status

NOTE: *-Leverage point

available from the Purchasing Agent as required. Other data concerning financial status, personnel availability, and quantity estimates are obtainable from the contractor's respective departments (21). The impetus for using a MIS is the fact that unprocessed data is fed into the system and the computer is responsible for compiling and correlating the information for subsequent production of control reports. This allows all levels of management to spend more time analyzing the data and not just creating it.

Computer hardware needs. The hardware needs for a MIS are as varied as the number of hardware producers. Depending on the user's desires the system could include large computer plotting devices with remote access terminals, or only require the services of a small business computer. For a comprehensive MIS the computer must have a large memory capability to retain the financial and estimating data in addition to processing the CPM schedule for each project. A minicomputer with accessible storage capability would probably be the smallest processor available (11). Line printers with multicopy capability are required to rapidly produce the various weekly and monthly reports in a timely manner. Due to the geographic dispersion of construction projects a remote input-output terminal would be required. This could be a cathode ray tube (CRT) console with a hardcopy reproduction capability. Communication lines and devices would be required for a remote processing system. Leased telephone lines with signal generators could be used. Figure 2 shows a hardware configuration which might be used. It could be enlarged easily because the equipment is modular. Modularity in this context means that the equipment is capable of being connected with additional devices to increase the system's capability. For example, the disc storage and tape storage devices in Figure 2



PROPOSED MIS HARDWARE CONFIGURATION

FIGURE 2

could be doubled by adding new storage units without rebuilding the entire system. Each piece of hardware is selfsufficient since it does not require outside help to perform its assigned task (1). The hardware problem can be eliminated if the contractor chooses to use a computer service. This is not always the best alternative since each contractor would have his own peculiar requirements for computer services and a generalized program would not adequately fulfill his needs.

Computer software needs. Computer hardware alone does not constitute the total processing system. Software or manipulative computer programs are essential to the operation of the system. Before any reporting programs are initiated it is necessary to have a program which will logically store and manage the data within the system. This is referred to as a data base management program. The data management system is able to retrieve information from many files and provide reports to the user. These systems can be designed to supply recurring reports in a standardized format and also allow the user to randomly query the computer for interm status reports. With proper planning the programmer can develop a flexible report format which can be tailored to the user's desires. In addition to flexibility, the software must be adapted to the user's existing reporting system so the data gathering and updating requirements will not be an alien burden to the field personnel. Many data management systems are offered by vendors of computers and software speciality companies (3). These systems are usually intended for a business or government application which are concerned with large inventories and billing lists. Construction companies do not deal with these types of data, since their work is project oriented and relatively few items must be controlled. A contractor would not maintain large inventories of material, nor

retain lengthy lists of personnel, or a sizable billing list. It is not being suggested that a data management system is not feasible for a contractor, but the existing systems would require modification.

Personnel needs. Assuming that the previously mentioned MIS requirements have been fulfilled, the last need is personnel. During the life of the system personnel costs could easily become the largest drain on the financial resources allocated to support the MIS. It is not always possible to assume that the new MIS will replace existing personnel and thus offset the system costs. Often, the present workers are retained, and additional specialists are hired to operate the system. These specialists will vary in number depending on the complexity of the system, but some basic skills such as keypunch or CRT operators and programmers will be needed. An administrator from the company must be appointed to oversee the development and operation of the MIS. This person would be in a position to match the needs of the company with the capabilities of the MIS. It is possible that existing secretaries could be retrained to be computer technicians, but the programmers would have to be hired and the administrator would need to be acquired. Though the personnel situation appears to be a deficit factor for the near future of the system, it must be recognized that a much larger work load could be handled in the future with very little modification in the personnel structure. For a firm in a growth pattern, computerization of the operation at a small scale is logical because it will be very difficult to changeover from a manual to an automated system when staff is large and the data are resting in file cabinets. Unless the staff was reduced, it is difficult to imagine how the computer system can pay for itself, since the management overhead costs will be excessive.

Feasibility of Information Systems

Value of information. At this point the need for a MIS and its general composition should be clearly established. The feasibility of such a system is the last facet to be explored. Typical analysis concerning feasibility rely on a cost to benefit study of the product under consideration. In this instance the product is information. Since information does not have any of the usual monetary dimensions, it is necessary to give it a characteristic called "quality." Information will have quality if it is accurate, timely, detailed enough for use, and representative of reality (4). As the quality increases so does the value and cost of the information. Careful design of the data base is critical to the success of the MIS both in terms of providing adequate data and not being too costly. Since the level of detail and length of storage are sensitive cost factors, the decision to limit this cost should be based on the expected value of the information being stored. This is a statistical problem because the expected value equals the probability that the information will be required, times the value of the information. This would necessitate high value, but the low use probability data being stored in detail for a considerable time. For a contractor this might be information related to material deliveries, or shop drawings. For most systems the balance point between data cost and value is considerably lower than retaining complete transaction data for more than short periods.

Cost to benefit analysis. Any attempt to quantify costs and benefits derived from a MIS should recognize that there are both tangible and intangible benefits. The difference between these two classes of benefits is the degree of difficulty in assigning a monetary value.

Costs can be readily computed from the hardware and software charges, and the additional personnel costs. These costs can be defined and prorated as a percentage of the overhead cost. The system's benefits are not as easily quantified because the end result is reflected in the management effeciency of the firm and in the overall quality of the information being produced. Tangible benefits could be identified if clerical positions are eliminated or if increased hardware efficiency results in lower equipment operating costs. These benefits can be analyzed in the traditional economic fashion with rates of return or present value computations. A second form of tangible benefit is an increase in the value of the information. There is an apparent improvement in the quality of the information, but there is less obvious increase in the monetary benefits (4). A MIS might allow the contractor to process his invoices for monthly payment in one-half the usual time. This in turn could minimize his cash flow requirements and thus reduce the amount of money he had to borrow. A cost savings could then be estimated and applied to the rate of return for the improvements in the MIS. Intangible benefits are usually derived from increases in customer satisfaction and improved customer service. A monetary value for these benefits is difficult to assess. but not impossible. For a contractor it is very important that his clients are satisfied with his work because follow-on contracts are financially rewarding. Increased control of construction projects which leads to timely job completion and cost control will be beneficial to the contractor because his reputation will be enhanced.

Once the costs and benefits have been reduced to numerical values the next step involves a series of trade-offs between the system's capabilities and the associated cost to benefit ratio. The user must decide

between the alternatives presented. This involves the introduction of subjective management evaluation which is based on both the tangible benefits and also on the intangible benefits. Since managers are paid to make judgements without having complete analytical data, it is not unreasonable to expect them to make a choice between the cost and quality of the MIS information. A contractor might be presented with a choice between printing work schedules for a weekly or monthly cycle. The level of data detail could be governed by the needs of the contractor's accounting system which could place an unrealistic demand on the field staff to generate voluminous input reports.

Feasibility studies. Any contractor who was serious about a MIS should approach the problem by instituting a formal feasibility study. For a small to medium size firm with no prior computer experience the study should conform to the following pattern (5):

1. An outside consultant should be hired to work full time with a knowledgable member of the staff.
2. The existing information flow patterns should be documented and specific recommendations made for improving the manual system.
3. Accrued benefits from the initial study should pay for the system survey. If it is found that a computerized system is not warranted, then the feasibility study should be shelved and updated regularly.
4. If computerization is feasible, then the firm's lifestream operations should be given priority for implementation.
5. A knowledgable data processing manager should be hired to coordinate the creation of the MIS, since the company does not possess sufficient computer talent. The data processing manager

5. (Continued) would be capable of dealing with potential vendors on a technical level to ensure that the final MIS was compatable with the contractor's needs.
6. Detailed system design and cost to benefit analysis should not begin until the preceeding steps have been accomplished.
7. Lastly, the contractor would have to make the final decision regarding the composition of the MIS. Proposals from vendors would be analyzed with the assistance of the data processing manager.

The feasibility study should pay for itself by improving the existing operation. Failure to develop these immediate benefits would only add to the skepticism and inertia towards a MIS. In order to enhance the chances of the success of the MIS it is essential that the contractor's management be involved in the program from the beginning and that specific objectives be established for the MIS. These two factors must be recognized at the initiation of the feasibility study.

After assimilating the background information presented in the previous paragraphs, the question still remains as to the feasibility of implementing a MIS for a construction company. No specific answers have been found, but some generalities have merit. A contractor with an annual contract volume of $6 million spread over 15 to 20 separate projects would be in the boundary area between manual and computer operation. Probably, some computerization has taken place, but no total MIS has been instituted (12). If this firm was in a growth pattern, then serious consideration should be made concerning a MIS. Dollar volume is not the only factor controlling the feasibility and subsequent success of the MIS. Both top management and subordinate personnel must support the system if it is to succeed. If the human factor is left out of the feasibility analysis, then serious difficulties could surface when the implementation

phase was undertaken. Too many variables are possible to predict the feasibility of a MIS, but the concept has definite possibilities if handled properly. Large computer vendors such as IBM, Hewlett Packard, National Cash Register Company and Burrows Business Machines are increasing their product lines to include small office computers with the capability to process comprehensive management information. This trend in itself indicates that small business market has potential for utilizing computers.

III. PROPOSED PROJECT MONITORING SYSTEM

The purpose of this section is to present a project monitoring system which can be used by the Superintendent on a building construction project. In addition to defining the various reports which will be used to input data and to receive information, it is necessary to discuss the underlying theory and rationale for selecting the various reports. Since this monitoring system is intended for field use, no attempt has been made to specify reports which other members of the contractor's staff would use. This monitoring system was developed by the author after studying many existing systems. None of the items in the reports are new to computer technology, but the organization and format of the proposed reports is new.

Level of Detail in Reports

Three areas of general computer technology were explored in developing the project monitoring system. The first factor was the level of detail for the field report. This question was compounded by the need to combine the work schedule with the cost control system. Work items in the schedule would have to be sufficiently detailed in scope to correspond with a standard cost account system. This problem was solved by subdividing each work Activity into subitems which would allow detailed definition of work, but would not confuse the work schedule with a multitude of Activities. A subordinate problem regarding level of detail concerned the need to provide the Superintendent with relevant data and not overpower him with unnecessary information. It was decided to limit the detailed breakdown of the work schedule to the Prime Contractor's work only, since the Superintendent was not responsible for monitoring

the Subcontractor's cost control. By reducing the work schedule printout to only the ensuing 60 day period, much irrelevant information was eliminated.

Flexibility of Reports

The second concept involved the flexibility of the system. The computer system itself was designed with the intention that the components would be modular. The field report is intended to allow the user to tailor the reports to his needs. This is accomplished by providing standard reports with the capability to suppress certain portions of the report. Items such as Activity Slack or cost could be deleted from the printout. Flexibility was also needed in the updating process because the system had to function with the least disruption to the existing data gathering methods. This required a simple input requirement from the field which was not time consuming.

Human Factors Governing Format of Reports

The third concern was for the human factors. These requirements have been reduced to a few straightforward guidelines which are listed below (4):

1. Use standard formats, headings, and definitions which permit the user to scan the display without interpreting each item.
2. Each item displayed should be labeled.
3. Avoid excess precision and provide summary data.
4. Use graphical displays when possible.
5. Present comparisons of the new data with the plan or standard values.
6. Provide descriptive links between displays to indicate the hierarchial relationships.

These six points are crucial to the operation of the monitoring system because compliance with them will enhance the chances that the reports will actually be read and used. Without the acceptance of the user personnel, no system, no matter how refined it is, can hope to succeed.

Format of Field Reports

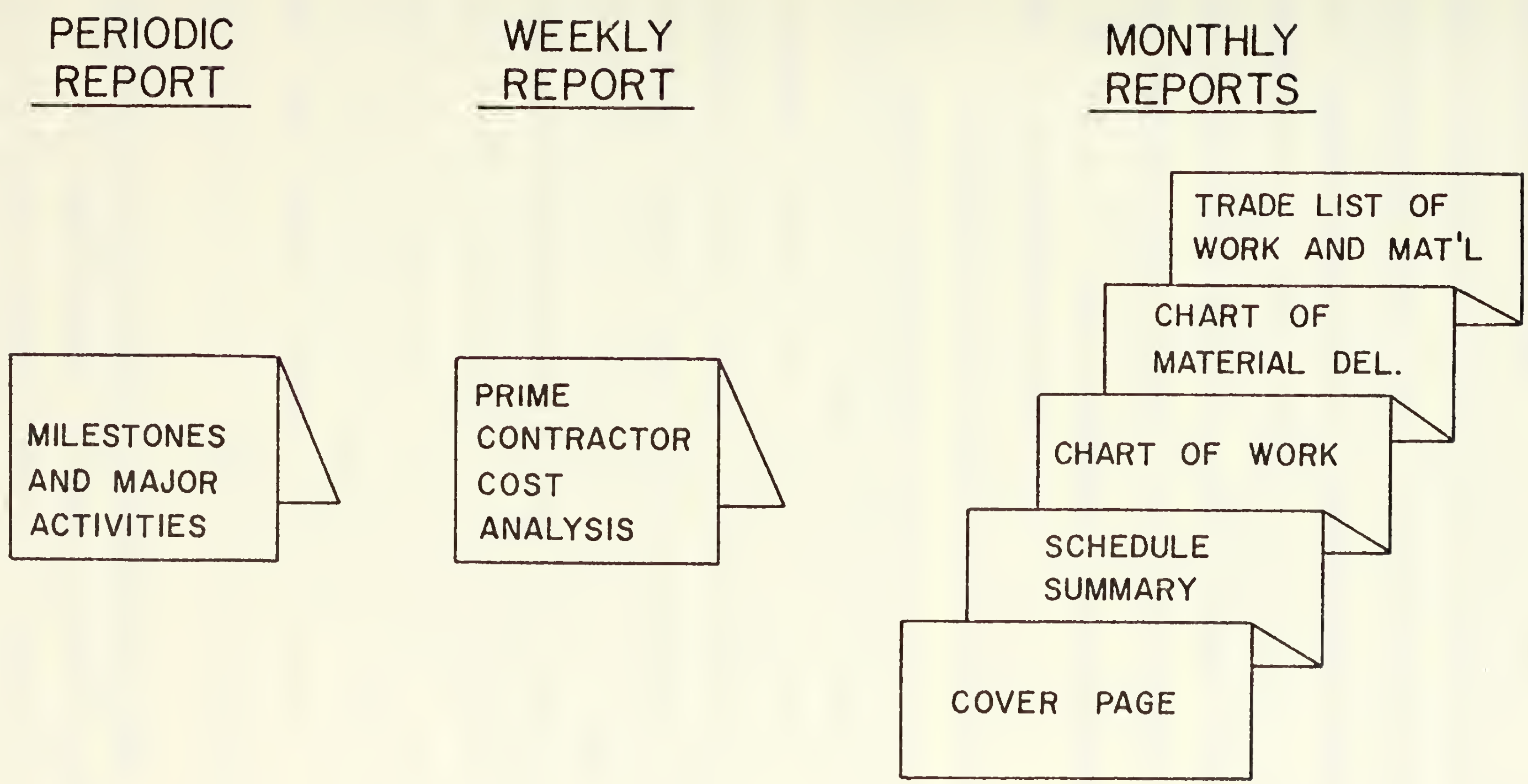
In an attempt to define present construction industry desires for a Superintendent's Project Monitoring System (SPMS) a survey was conducted among the building construction firms listed in the 10 April 1975 issue of Engineering News Record, "THE ENR 400." Appendix B contains the questionnaire which was sent to the top managers and summaries of the data which were gathered. The survey not only provided an insight to existing computerized scheduling systems and desires for a future system, but it showed that success of the monitoring system was dependent upon the Superintendent's involvement with the system. Based on the survey results the following information requirements for a Superintendent's control system were identified:

1. Detailed schedule of work for the next 60 days.
2. Early Start sequence of activities with slack shown.
3. Computer printed bar chart of work and material deliveries for the next 60 days.
4. Manpower required to meet the schedule by work activity.
5. Manpower required to meet the schedule by subcontract responsibility:
6. Grouping of activities by subcontract responsibility.
7. Detailed schedule of material deliveries for the next 60 days.
8. Capability to show actual versus projected work schedule in a computerized bar chart.

9. Summary charts showing progress to date, man-hours expended to date, and estimated man-hours to finish.
10. Comparison of actual versus estimated unit costs by work activity.
11. Exception report showing items which are late starting.
12. Equipment required to meet schedule.

These requirements were used in creating the reports for the project monitoring system shown in Figure 3. The Superintendent is given a weekly cost analysis report by Activity for those prime contractor items which were either over or under the estimated cost. The monthly reports provide a schedule of work and material deliveries for the next 60 days for both the prime contractor and the subcontractors. Appendix C contains sample formats for the reports, descriptions of each section in the printout, and explanations of the calculations for each section.

The rationale for selecting this format with these specific sections is a combination of research and personal preference. Since two primary concerns of a Project Superintendent are time and money, it was decided that the proposed system should emphasize these aspects. The cost report is processed weekly on an exception basis to highlight those Items which are deviating from the estimate. Since construction processes are not highly repetitive, it is essential that corrective cost control action be taken in a timely manner. The second group of reports are printed monthly and they deal with the time scale of the work. The Superintendent is given a graphical display of the various Items which are scheduled for the next 60 day period for both work and material deliveries. The intention is to provide the Superintendent with an outline of the progress required and to let him perform his own detailed daily work



SUPERINTENDENT'S PROJECT MONITORING SYSTEM
(SPMS)

FIGURE 3

scheduling. Weekly requirements for manpower are provided to indicate the level of effort needed to meet the schedule. Summary statements are made in the report to give an overall status of the project without having to read the entire report. Since the Superintendent is responsible for the prime contractor's cost control, detailed cost information is provided for both the actual and estimated costs. The schedule period of 60 days was chosen because the Superintendent is primarily concerned with the immediate future and does not plan too far ahead. Latter sections in this thesis will discuss the methods for collecting the input data and how it is processed to provide these reports.

In addition to the reports described above, the Superintendent will receive a Milestone/Logic Diagram at the start of the project and it will be revised as necessary during the construction phase. Appendix C contains a detailed description of the components of the diagram. This diagram will contain the major work and material delivery Activities in a bar chart format to give a visual presentation of the work logic for the entire project. The Activity 'I' and 'J' numbers are shown on the computer printed diagram to indicate the interdependence of the Activities. The Activities can be arranged in many combinations such as by trade responsibility, or by work area, or by criticality. In any event, the Activities would be shown in an accending order of their 'I' number to allow easy visual tracing of the work logic, since the 'J' number of the preceeding Activity is the 'I' number of the succeeding Activity.

Relationship of Field Reports to Information Systems

This Superintendent's Project Monitoring System (SPMS) is intended to be used with an integrated MIS for a construction company. The SPMS will require access to the accounting, payroll, purchasing, and schedule

files in order to produce the required reports. This operation will be discussed in a latter section. A key element to the SPMS is the conversion of the schedule data into useful cost control data. As previously mentioned, each Activity is subdivided into Items of specific work, which are compatible with the cost control accounts. The Estimator and Scheduler create a conversion matrix between the Activity-Item numbers and the standard cost accounts which is entered into the computer. This will reduce the number of coding lists to only the Activity-Item listing, since the cost account list will be internal to the computer. As the input reports are processed with Activity-Item numbers, the proper cost account will be automatically charged.

Relationship of Field Reports to the Present State of Computer Technology

Though the SPMS is not an operating system, it is felt that it could be implemented with existing technology. The various components of the SPMS exist in a similar form as seen in samples from contractors and vendors. That is to say that none of the components in the SPMS are new to computer application, but the overall system and report organization is new. Implementation of the SPMS will probably reveal problems which have not been considered, but the concept of the SPMS is feasible now. This statement will be justified in later sections of this thesis with a simulated operation of the system.

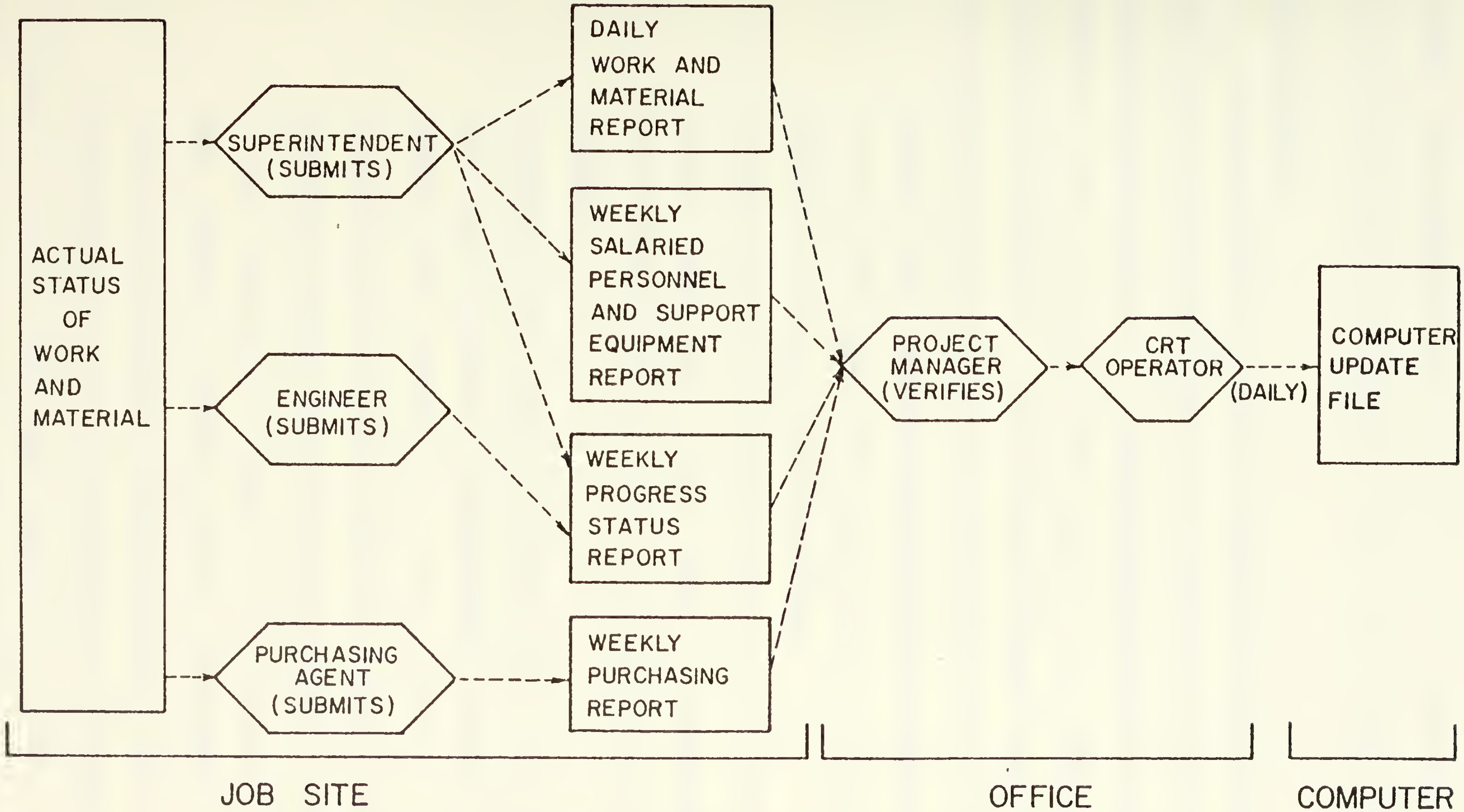
IV. IMPLEMENTATION CONSIDERATIONS OF SPMS

No proposed scheduling and control system should be implemented unless it can be shown that the input data can be acquired and the data gathering process is not cumbersome. It is also necessary to determine the method of calculating the various elements in the printout. This section will therefore be concerned with establishing forms and procedures for both data gathering and data processing.

Data Gathering

Input forms. After a work schedule has been created with the help of the Project Superintendent, it is essential that the schedule be updated regularly if it is going to be an effective control tool. Information must be gathered regarding work complete, material status, and testing. The most convenient way to obtain this data is to utilize the reports that the Superintendent normally submits on a daily or weekly cycle (9, 12, 15). Usually the Superintendent submits a daily labor utilization report for each of the prime contractor's workers; a report of any material received that day; a report of the equipment used, and an indication of subcontractor activity. A weekly status report is submitted showing the percentage of work complete with a narrative explanation. These reports are manually prepared by the Superintendent or his assistant on preprinted forms which combine all of the information on one form. The weekly status report is prepared in a similar fashion. The only major change to this "typical" system will be to substitute Activity-Item numbers for the usual cost account numbers. The basic forms and reporting procedures will be the same as the "typical" system with man-hours for each prime contractor employee being reported for both regular time and overtime. As new

work is started or other work is completed, the Superintendent will indicate the actual start and finish dates as the work progresses on a daily basis. When material is delivered to the job site, the Superintendent will log it on the daily report and "charge" any handling costs to the "Delivery" Item for that material. If material is placed directly when delivered such as concrete, then the "Work" Item will be used to "charge" the material cost. The flow of information from the field to the computer is shown in Figure 4. Adequate documentation is maintained with a Daily Work Report, a Weekly Progress Status Report, a Weekly Salaried Personnel Report, and a Weekly Purchasing Report. Appendix D contains the report forms with a detailed description of each element in the report. These four reports were selected for their conformance to a "typical" reporting system, and also because collection of data on a short cycle such as daily or weekly would decrease the volume of input data to be processed at one time. A significant benefit from this short processing cycle would be the increased value of the information due to the timeliness of the output data. By necessity, the daily reports must be detailed to provide a comprehensive picture of the work site activity. The information from these reports will serve to update the control system and also provide evidence for disputes arising from failure to complete the contract on time, or defects in the work. Once the data has been acquired in a raw form from the field, it is transmitted to the computer after it was been verified and reviewed by the Project Manager. Manual operations for the field personnel are not being significantly reduced by the SPMS reporting requirements, but they are not being increased either. Management demands for random status reports will not be directed to the Superintendent since the visual displays from the computer can provide the most current status.



INFORMATION FLOW FROM FIELD TO COMPUTER

FIGURE 4

Valuable field management time will not be used to summarize raw data or create status reports for a period of time longer than one week.

Data Processing

Data processing involves the organization of the raw data into a usable form and then manipulating it to provide the values needed for the various status reports. A clearer understanding of the relationship between the input data and the output reports for the SPMS can be gained by referring to Appendix E. The following statements provide the underlying reasoning for the composition of the various input reports:

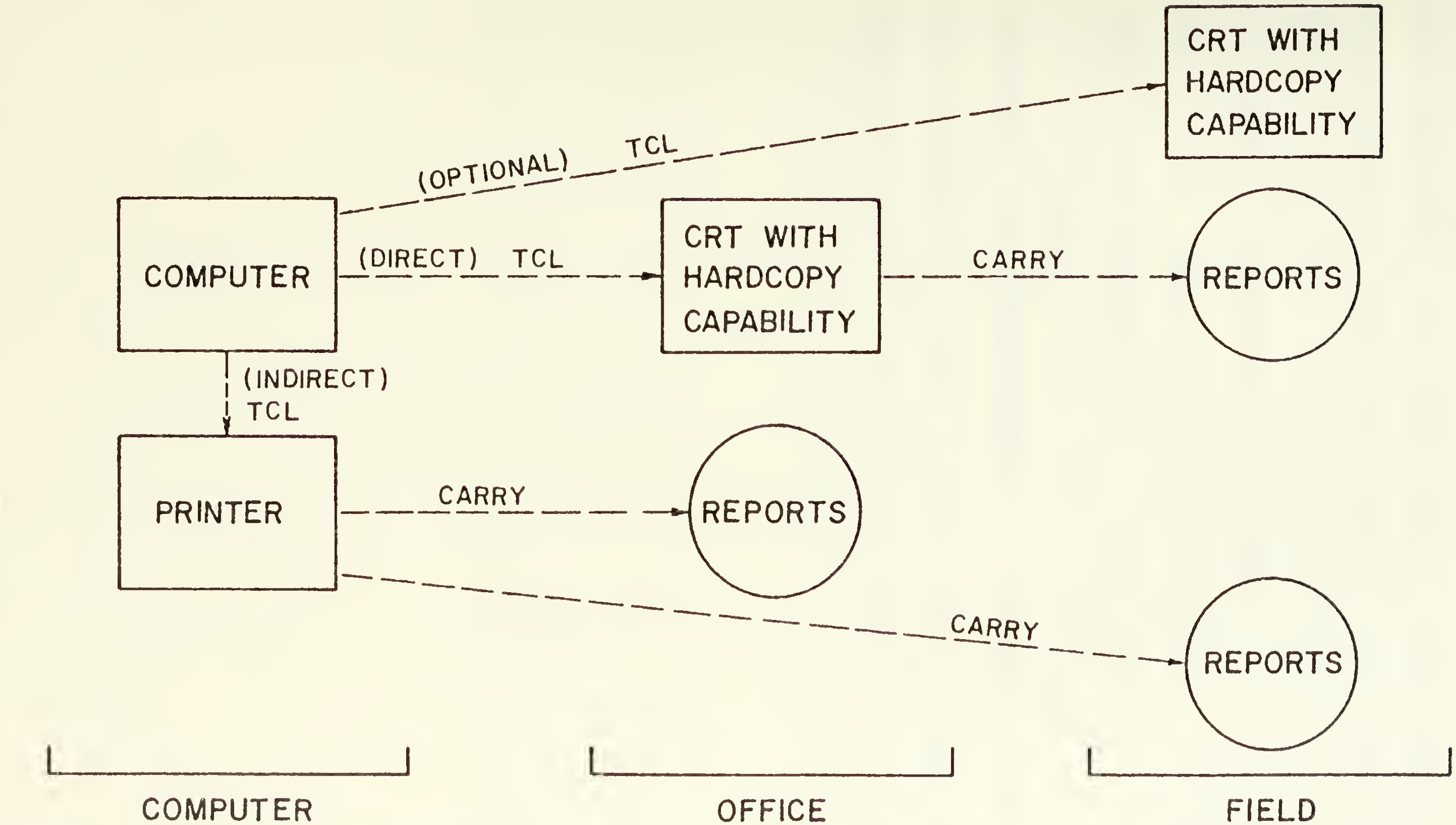
1. The Daily Report requires input by Activity-Item numbers for the prime contractor's labor, material, and equipment to match the needs of the cost accounting system.
2. The Daily Report does not require input for subcontractors by Activity-Item numbers for labor, material, and equipment because the prime contractor does not maintain detailed subcontract cost accounts.
3. The Weekly Progress Report allows the status to be reported by either percent complete or workdays remaining to allow rapid updating of the progress and to show revisions in the schedule.
4. The Weekly Salaried Personnel Report indicates salaried labor distribution without any Activity-Item numbers, because the overhead costs are not "charged" directly to any Activity.
5. Weekly progress is reported by Activity-Item number for both the prime and subcontractors to allow updating of the total schedule.

Understandably not all of the information in the output reports is derived from the four field input reports. The estimated costs for labor, material, and equipment are taken from the contractor's cost

estimate. The computerized cost estimating system is able to convert direct costs into total costs by automatically marking-up the direct costs into total costs with the appropriate overhead and profit percentages. Major equipment requirements are taken from the cost estimate by type of equipment. The Scheduler and Estimator create a conversion matrix between the Activity-Item numbers and the major equipment types which will be needed for each phase of the job. They also create a correlation table for the Activity-Item numbers and the standard cost accounts. The estimated manhours for each of the Activity-Item numbers is found in the detailed quantity estimate. Subcontractors would submit information relating to labor, material, and equipment costs, and time requirements, but not with the same degree of detail as the prime contractor.

Figure 5 indicates the flow of the output reports from the computer to the field. Rapid processing is mandatory because the last input report is received on Friday afternoon, and the status reports are due on Monday morning. Since the system does not rely on mail service, it is possible to process the data and distribute it over the weekend. Reports are sent to remote printing terminals over telecommunications lines. Bulkier reports could be delivered by messenger. The CRT with a hardcopy reproduction capability can be used in the field for random status reports.

Scheduling for a construction project is a dynamic operation because of the numerous changes which occur that result in a modification to the schedule. These changes can be initiated by the contractor or the owner, but the end result is a readjustment of the Superintendent's schedule. The SPMS can handle both major and minor changes to the contract cost and time for completion. A major change would require the creation of new Activity-Item numbers to identify work which was not



NOTE: TCL = TELECOMMUNICATIONS LINE

CRT = CATHODE RAY TUBE TERMINAL

INFORMATION FLOW FROM COMPUTER TO FIELD.

FIGURE 5

previously part of the contract. Minor changes are accommodated by adding time and/or money to an existing Activity-Item number. Part of the change order negotiations will include a decision regarding the exact modifications which must be made to the work logic and Activity-Item list to reflect the new work. If an existing Activity-Item is increased in cost, the percentage of completion will automatically be reduced to indicate the new status. When Activity-Item durations are increased the critical path will be recalculated and a revised schedule will be printed. Since the formal change order with a detailed description of the new work is transmitted to the Superintendent, the printout will only show the fact that the schedule is current through a specific change order. Major changes will require an interim work schedule, while minor changes will be incorporated into the work schedule during the next monthly printout.

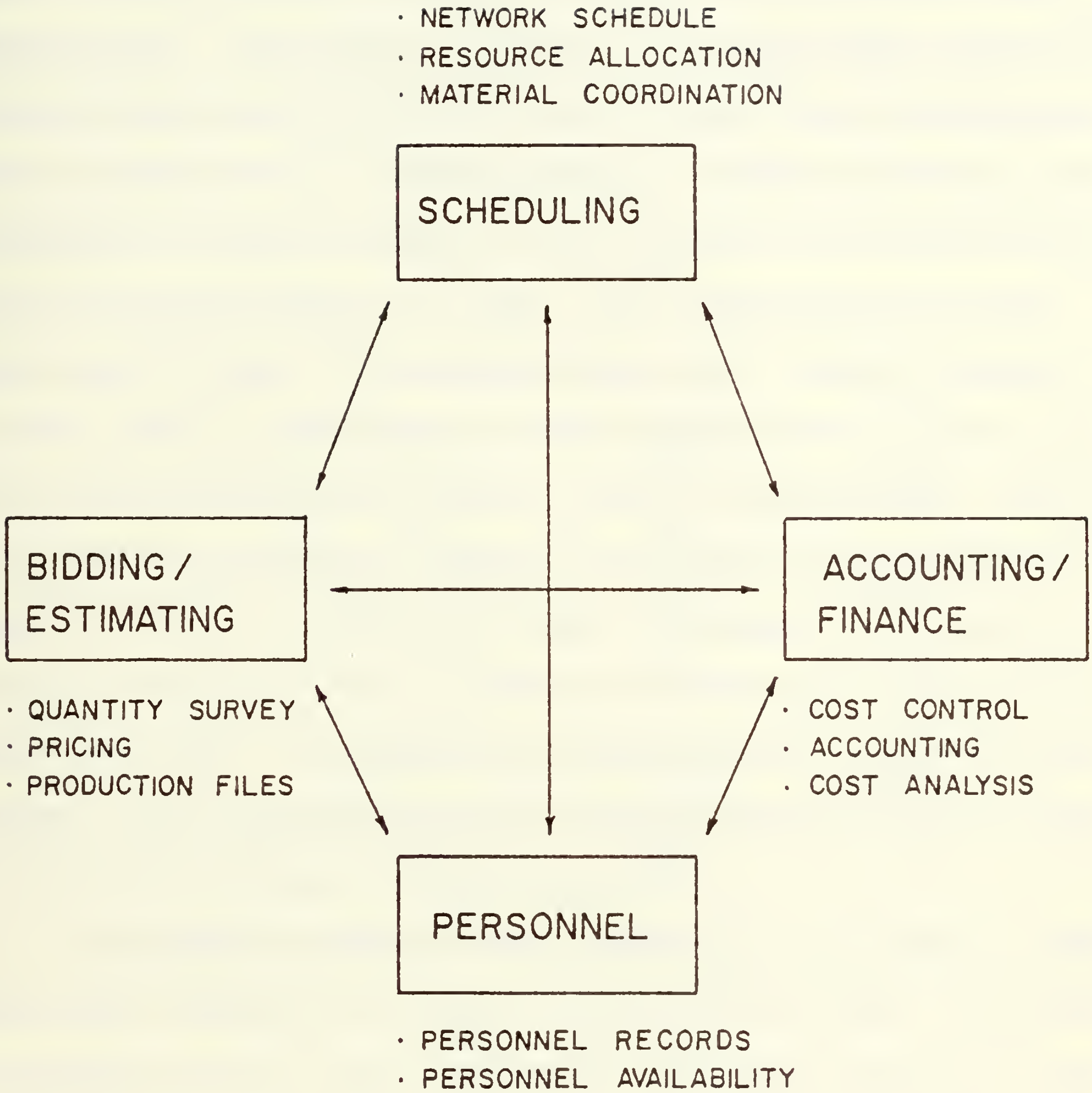
V. SIMULATED OPERATION OF SPMS

Hypothetical Information System

Before attempting to present any simulated forms or reports for the SPMS it is necessary to define a hypothetical construction company which is utilizing a MIS. This fictional contractor operates on an annual contract volume of 20 million and uses a Superintendent for each of the nine building projects which are under construction. The management control system for this medium sized contractor contains a computerized information system which processes data relating to Scheduling; Bidding/Estimating; Accounting, and Personnel. Figure 6 shows the interdependence of these four systems and highlights the fact that the decisions and control parameters in one area have an effect on the other areas. (i. e. Unit costs are based on accounting data and they also effect the duration estimates for scheduling). Personnel control information was added to this system because the contractor's business is labor intensive and it is essential to get the "right" man for each project. Since one of the highest factors contributing to project success is the proven ability of the management personnel, job assignments are very important.

Method of Creating the Schedule

The contractor uses the SPMS as an integrated part of his overall MIS. A CPM schedule is used on all projects with varying degrees of detail depending on the complexity of the job. After a contract has been awarded, the first step in the SPMS is the development of a work logic diagram. This is developed in a very rough form with milestones for excavation; structure erection; exterior walls; interior walls, and finish work. The Scheduler, Project Manager, and Superintendent are responsible for



MANAGERIAL CONTROL SYSTEM
INFORMATION FLOW

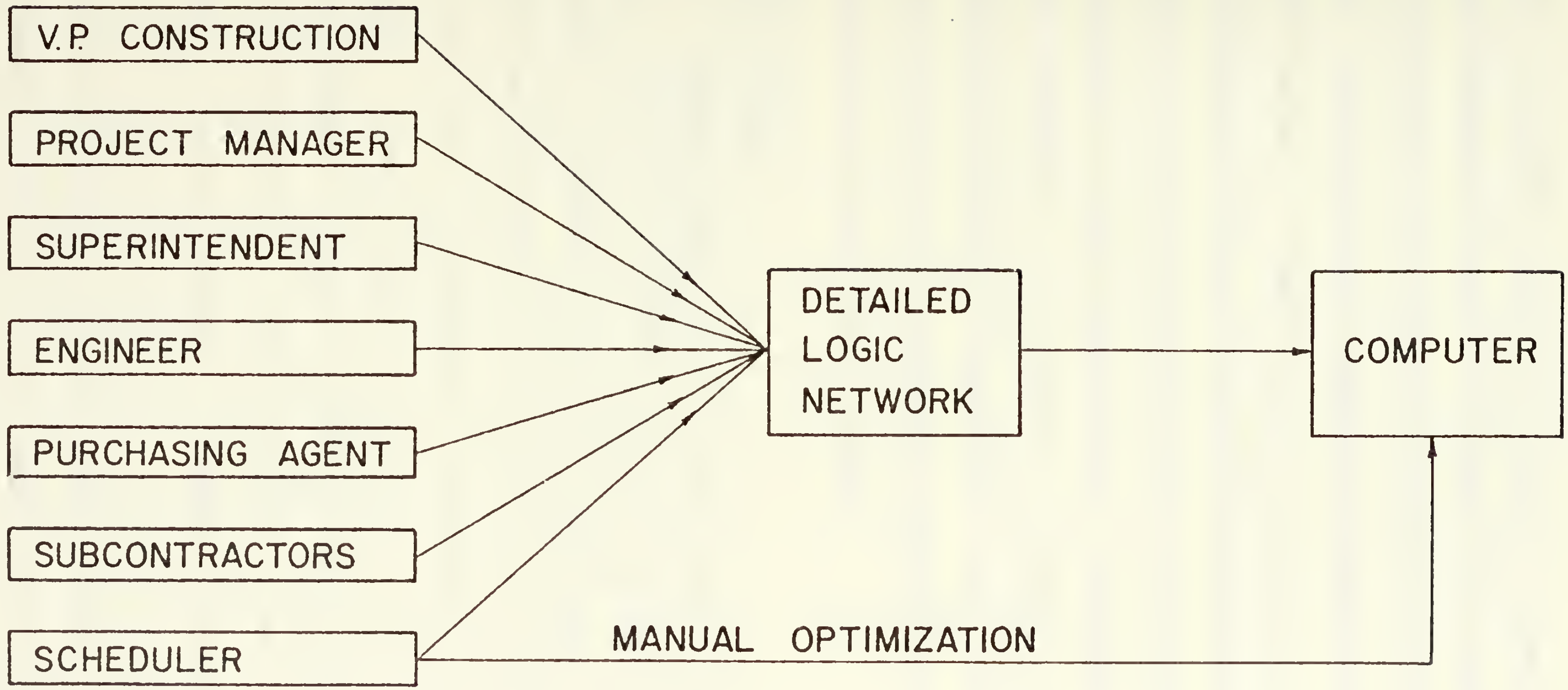
FIGURE 6

this initial schedule. Figure 7 shows that the method of developing the detailed schedule involves the V. P. of Construction; Project Manager; Superintendent; Engineer; Estimator; Scheduler; Purchasing Agent, and Subcontractors. This group will define a work network which relates each Activity-Item to the other Activity-Items and specified a minimum duration for each Activity. Since the project is divided into phases by the milestones, the detailed schedule is only created for the next phase and not for the whole project at one time. The Subcontractors are interviewed prior to their work commencement date, and a detailed schedule for their work is created based on their production rates and crew sizes. In this way the minimum durations are found for the Activities. The computer is used to optimize the schedule as the details are generated and the schedule is filled in. Once the schedule is approved, the Scheduler creates a conversion table to translate the Activity-Item numbers to appropriate cost codes. The Estimator has already put the cost codes on the estimate, and the estimate was used to generate the durations and costs for the prime contractor's portion of the work.

The computer hardware for this contractor is very simple. Remote input/output terminals are located in the main office with a line printer. The computer service is obtained from a large computer working on a time sharing basis. This allows the contractor the maximum flexibility since he does not have to finance a costly computer facility, but still gets timely response for his update reports.

Output Reports

The particular project being monitored by the SPMS is a $4,650,000 Applied Instruction Building for the U. S. Navy. The total contract time is 540 calendar days with a CPM network of 1,000 activities. Work started



SCHEDULE DEVELOPMENT

FIGURE 7

on 18 June 1974 and the status as of 28 March 1975 indicates that the work is 62 calendar days behind schedule. Appendix F contains the simulated computer printout for the Weekly Cost Analysis of 28 March 1975 and the Monthly Schedule Report for the 60 day period starting 31 March 1975. A Milestone/Logic Diagram is included for clarification of the overall schedule. Though not all of the Activity-Items were listed in the simulated printouts, it should be realized that an actual report would not have many more pages to read. By expanding a small segment of the schedule for each 60 day period, it is possible to provide more detailed information. In addition to the general contractor, there are six subcontractors working on the project. The level of detail in the printouts varies for each subcontractor depending on the amount of data each one provides to the general contractor.

Update Schedule

Routine input data. The next group of reports needed for a complete simulation of the SPMS cycle are the field input reports. Appendix G contains the Weekly Reports and a Daily Report for 4 April 1975. These reports could be filled in by hand, but it is recommended that a typist be used to avoid any problems in transcribing the input data for the computer. A verbal report is made daily to the Project Manager by the Superintendent is discuss any unusual events and to communicate any anticipated difficulties. The Daily Report is used to record any important aspects of these discussions. It should be noted that the input reports have very little data on them. As the work progresses and more subcontractors are active on the site, then additional entries will be needed. The progress reports will not be difficult to produce, since the "Update" section of the "List of Material And Work Report" can be attached to

indicate the revised status of the work. The "Weekly Salaried Personnel/ Support Equipment Reports" could be eliminated if the personnel and equipment status were constant. These values are used to "charge" the field overhead to each job, and do not affect the schedule data. A predetermined monthly cost could be associated with each project to reflect these field overhead expenses. The report would only be submitted when the field conditions varied from the established values. These reports are not meant to supplant normal communications between the contractor's field construction personnel and the office staff, but they are intended to provide a record of what has transpired. Since both the Purchasing Agent and the Superintendent are buying materials for the project, the Superintendent is given a block of Purchase Order numbers for his use. There is also a limitation on the dollar value of the Purchase Orders that the Superintendent can issue. This allows the Purchasing Agent to negotiate more favorable conditions for the larger purchases.

Nonroutine input data. The previous paragraph was concerned with the routine update data which would be found in the Daily and Weekly Reports. Once the data were fed into the computer no further action was required. This is not the case when the nonroutine items are encountered. If a change order is initiated which affects the duration of any Activity in the schedule, the network must be checked to determine the impact on other Activities and also on the project completion date. The Scheduler, Superintendent, and Project Manager would all be involved in revising the schedule to avoid delaying the completion date. Since all Activities are scheduled to start on their Early Start date, it would be possible for the Superintendent to delay some noncritical Activities in order to proceed with the change order work. This type of management

action would be required for situations where no change order was involved, but the work was behind schedule, or an unavoidable delay was encountered. Since only the short term schedule is presented to the Superintendent, it would be relatively simple for him to identify the Activities which could be rescheduled. Material deliveries can cause unnecessary confusion if they are not handled properly. Decisions must be made early in the job regarding the methods of charging reusable materials. Forming wood is usually delivered in bulk and used as it is required. Since many Activities are involved, it would be reasonable to charge all of the material to the first Activity requiring forming. This would simplify the field reporting responsibility and still provide accurate cost data because the total area formed would still be recorded and it would be simple for the computer to total all of the Forming Activities to acquire a unit cost.

Comparison of Methods to Typical Monitoring System

Table 2 indicates the differences between the SPMS reporting system and a typical system which is manually operated. The main point to grasp from this Table is the lack of significant differences between the two systems. The report formats and types of information being gathered are the same for either system. The manual system would require cost account numbers to allow distribution of costs, while the SPMS relies on the Activity-Item numbers from the schedule to distribute costs. The greatest impact of this new system will be felt by the Scheduler, since the conversion matrix between the Activity-Item numbers and the Cost accounts must be created for each project. This should be a reasonable task because the schedule is based on the detailed estimate, which is keyed to the cost codes. Daily use of the schedule by the Superintendent

TABLE 2

Differences Between a "Typical" Manual Reporting System And The SPMS Reporting System

Report Originator	"Typical" Report	SPMS Report
Superintendent	-Daily labor, material, and equipment for prime contractor keyed to cost codes, and notes on sub-contractor activity.	Same information, but keyed to Activity-Item numbers.
	-Weekly work progress status with narrative report.	Same information, but keyed to Activity-Item numbers. Greater detail required, but preprinted forms require only percent completion.
	-Monthly status of project in narrative form with percent completion.	Not required, since the computer generates this report from the weekly and daily reports.
Timekeeper	-Daily work assignments for prime contractor hourly workers by cost account numbers	Same information, but keyed to Activity-Item numbers.
	-Weekly salaried workers hours keyed to cost accounts.	Same information, since overhead costs are not keyed to Activity-Item numbers.
Engineer	-Weekly status of tests and shop drawings.	Same information, but keyed to Activity-Item numbers.
Purchasing Agent	-Weekly subcontract award status, material order status, and material delivery status.	Same information, but keyed to Activity-Item number.
Scheduler	-Monthly bar chart showing progress.	Not required, since the computer prints this report

is dictated by the requirement to report all work by the appropriate Activity-Item number. The Scheduler will have to remain in close contact with his projects to ensure that the schedule remains realistic through the construction phase. It will not be possible to simply draw the logic network and provide a monthly printout of the Activities. The increased levels of expertise required to combine the scheduling and cost accounting functions with a responsive computer system are to be drawn from the technical staff and not from the field staff. Some education of the field personnel will be needed, but the largest effort to effect implementation of the system will come from the prior work of the technical staff in creating readable and informative reports.

VI. CONCLUSIONS

Feasibility of Proposed Monitoring System

No final conclusions can be drawn regarding the feasibility of the project monitoring system which was presented in this thesis until such time as it is operational. It is possible to surmise some general observations concerning the future of this monitoring system. A medium sized contractor with growth potential and aggressive management leadership would be the most likely candidate to embrace this system. If the computerization were taken in incremental steps with preplanning and concurrent training of all user personnel, then the chances of creating a successful system application would be assured. Assuming that the contractor had little prior computer experience it would be essential that a competent data processing manager be added to the staff.

It cannot be overemphasized that the human element is the most important factor in the equation for successful implementation of any management system. It is essential that the system developers consider the desires and problems of the system's users. Willing acceptance of a system is more important than creating a monument to computer technology.

Recommendations for Further Study

Before any attempt is made to operate the SPMS it is necessary that additional work be undertaken to accomplish the following short term goals:

1. Revise the questionnaires in Appendix B to find out what the existing reporting requirements are for a Superintendent using a CPM system and a manual system.

2. Provide samples of the simulated reports to selected contractors for their evaluation and feedback. These contractors would be chosen from the active participants in the original survey. (i. e. Turner Construction Company, Yeargin Construction Company, McKee Construction Company, Jacobs Engineering, and any other firm which sent a sample of their existing reports).
3. Assuming that the responses to the second survey are less than 70% of the possible total, a random survey will be required to verify the results. In order to obtain a 10% response from the nonrespondents, it will be necessary to send out questionnaires to 30% of the nonrespondents. This is necessary because the random sample must be at least 10% to have any validity.

The long range goals for the creation of SPMS are as follows:

1. Based on the last survey the final formats for the field reports must be established.
2. Computer programs capable of generating the specified field reports must be written and checked for errors.
3. Simulated operation of the system with data taken from existing schedules must be accomplished on a computer using a CRT for updating the files.
4. After the system has proven its reliability, then the final process will be to define a hardware package which can process the data as specified.

VII. SUMMARY

In the 19 years since computerized scheduling was introduced in the form of CPM, the construction industry has not accepted this technique as widely as was expected. Early users had difficulty obtaining comprehensive computer service, and later users were faced with increased complexity in construction. Attempts to computerize schedules for the latter group of contractors were frustrated because the computer systems had improved, but the software programs were not capable of monitoring the construction process. In any event, the ultimate user of schedule information, namely the Superintendent, was not being given the information he needed in a form that he could understand.

An essential portion of the background knowledge needed to understand the monitoring system which was proposed in this thesis is the concept of a management information system. The combination of computers and management decisions by the contractor is the crux of the information system. By using the computer to store and correlate the multitude of input reports, and to produce summary as well as detailed output reports, the contractor's managers can spend more time evaluating the project instead of just generating the data.

The proposed Superintendent's Project Monitoring System (SPMS) is based on current industry practice and existing computer programs. In addition to searching current books and periodicals, a survey of the large building contractors in the United States was undertaken to define the present state of CPM application to construction. The resulting system is a combination of the best features found in many systems. Basically the system provides the Superintendent with weekly cost control information on an exception basis, and a monthly indication of the work required

in the next 60 calendar day period. These monthly reports include summary data regarding the overall project status to date, and detailed schedule information by trade responsibility. The work and material portions of the project are listed separately in a bar chart format to allow easy recognition of the flow of the work.

In order to justify the feasibility of the proposed monitoring system, it was necessary to develop input reports which would allow the system to be updated. A "typical" construction reporting system was adapted to the needs of SPMS. The input reports are generated on a daily and weekly cycle with the Superintendent providing most of the data.

A simulated operation of SPMS was developed from an actual project which was scheduled using a standard CPM program. Both the input and output reports were included to give a realistic representation of the methods and procedures required to maintain the SPMS.

No final conclusions were drawn regarding the feasibility of SPMS, but it was proposed that a medium sized construction firm would be the most likely user of this system. This was based on the premise that an expanding company of that size would be able to computerize at a relatively small cost with a minimum of personnel changes, and would be able to expand its scale of business rapidly in the future. Before any attempts are made to create the operating system, it is necessary that a second survey be undertaken to get some feedback from contractors on the weaknesses of SPMS and also to determine the existing reporting requirements that are placed on the Superintendent. After these two steps have been accomplished the final phase in the development of SPMS will be to write the computer programs and to specify the computer hardware needed to support the system.

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APPENDIX A

Survey of CPM Use By Building Contractors

A survey was undertaken by the author in January of 1976 to determine the present Building Industry approach to Building Construction Project Scheduling using Critical Path Methods (CPM) at the Superintendent level. Many techniques have been developed utilizing computers to assist in construction scheduling, but there was a real need to define the best method of translating computer oriented data into useful, understandable information for the ultimate user of schedule information, namely the Project Superintendent. Prior surveys have not dealt with this specific topic in the context of Building Construction uses and needs of CPM at the Superintendent level. In addition to determining the basic content of the respondent's reports used by Superintendents, it was desirable to discover what types of future CPM reports would be most useful to the Superintendent. A major concern of the survey was to establish a correlation between the success of the existing scheduling systems and the Superintendent's involvement with the system.

The survey was conducted by sending questionnaires to the top managers of the building construction companies listed in the 10 April 1975 issue of Engineering News Record, "The ENR 400." Of the 255 firms which were listed as building constructors, the names and addresses of 219 of the top corporate officers were obtained. The 82 respondents were evenly distributed by volume of business among the Top 400 firms, and only two of the replies were unusable because they did not provide answers to the questionnaire. See Tables 3 and 4 for the distribution of replies grouped by dollar volume of annual business for both the initial survey and the random sample. It should be noted that a predominance of successful CPM users replied to both questionnaires. This reinforces the concept that bias was present in the survey (17). It appears that firms which have had

TABLE 3

Distribution of CPM Users in the ENR Top 400

Construction Companies

Category	Grouping of Respondents Ranked by Volume				
	1-100*	101-200	201-300	301-400	Total
Total possible	61	64	61	69	255
Total received	22	18	21	21	82
CPM users	14	10	12	10	46
a. Successful	12	8	8	7	35
b. Unsuccessful	1	0	0	1	2
c. Don't know	1	2	4	2	9

* Dollar volume of annual business expressed in millions for each group is as follows:

Group	Range of Dollar Volume (Millions)
1-100	6,247.5 to 105.0
101-200	103.8 to 52.1
201-300	51.8 to 36.7
301-400	36.7 to 25.8

TABLE 4

Distribution of Random Sample Replies in ENR Top 400 Construction Companies

Category	Grouping of Respondents Ranked by Volume				
	1-100*	101-200	201-300	301-400	Total
Total queried	7	5	1	2	15
Total replies	4	1	1	0	6
CPM users:	3	0	1	0	4
a. Successful	2	0	1	0	3
b. Unsuccessful	0	0	0	0	0
c. Don't know	1	0	0	0	1

* See note for Table 3

poor experience with CPM did not respond to the survey. It is not known if a significant number of the nonresponding firms have a superior CPM system which they will not divulge because it represents a technological advantage for them. The likelihood of the latter case occurring is remote, so the only bias worth mentioning is the lack of replies from unsuccessful CPM users. Since the intention of the survey was to analyze existing CPM systems and draw the good features from each one into a new composite system, it is not a serious defect to be deficient in data on systems which have failed. With only a 37% response to the initial survey, it was decided to randomly sample the nonrespondents with a condensed version of the initial survey. Appendix B contains the questionnaires from both surveys as well as a summary of the responses. The response to the random survey was a respectable 40% of the questionnaires sent out. No significant trends were identified in the random survey which would reverse the conclusions from the initial survey. Tables 5, 6, and 7 indicate the positive relationship between the overall success of a CPM scheduling system and the Superintendent's input and use frequency of the system. These three Tables relate these factors in various combinations, but they all show that successful CPM systems are characterized by major or moderate input to the work logic by the Superintendent, and frequent or occasional use of the system by the Superintendent. Likewise, frequent or occasional use of the schedule system by the Superintendent is linked with major or moderate input by the Superintendent to the work logic. The following conclusions were drawn from the initial survey and are supported by the random survey:

1. Critical Path Methods (CPM) are <u>normally</u> used on building projects according to 56% of the respondents. Bar charts are <u>normally</u> used

TABLE 5

Comparison of Superintendent's Use of the CPM System to the Overall Success Rating of the CPM System

	Superintendent's Use Frequency			
Success Rating	Frequent	Occasional	Rare	Never
Very successful	11	1	0	1
Moderately successful	13	17	0	0
Partially successful	1	6	3	0
Unsuccessful	0	3	3	1
Don't know	5	6	4	1

TABLE 6

Comparison of Superintendent's Use of the CPM System to the Degree of Superintendent's Input to the CPM System

	Superintendent's Input			
Use Frequency	Major	Moderate	Minor	None
Frequent	20	8	1	0
Occasional	12	19	2	0
Rare	3	3	3	1
Never	1	1	0	0

TABLE 7

Comparison of Superintendent's Input to the CPM System versus the Overall Success Rating of the CPM System

	Superintendent's Input				
Success Rating	Major	Moderate	Minor	None	Total
Very successful	10	3	0	0	13
Moderately successful	16	13	2	0	31
Partially successful	7	2	0	1	10
Unsuccessful	3	3	2	0	8
Don't know	3	12	2	1	18

1. (Continued) by 41% of the companies. The remaining 3% had various other methods of scheduling, but none were relevant to this study.
2. The average minimum building project cost which warranted a CPM schedule was $3.5 million. The most frequently stated minimum cost was $1 million. Other factors, such as timing and project complexity were noted as contingent reasons for requiring a CPM schedule.
3. Of the companies using CPM, the following personnel read and implement the CPM printouts to formulate daily or weekly work schedules:
    a. Project Manager - 85% of the replies
    b. Superintendent - 81% of the replies

    (Scheduling Engineers were sometimes used to interpret the printouts for Project Managers and Superintendents).
4. Among the firms employing CPM schedules, the following <u>field level uses</u> were identified:
    a. Control of work and material delivery - 76% of users
    b. Control of project milestones - 71% of users
    c. Shop drawing and submittal control - 36% of users
    d. Control of subcontract awards - 19% of users

    (Other uses reported were manpower control and reports for substantiation of possible claims).
5. Project Superintendents receive schedule information in many forms. In order of descending occurence frequency, the following reports are transmitted to the Superintendent:
    a. CPM network alone - 16% of respondents
    b. Bar chart alone - 15% of respondents
    c. Printouts by early start sequence with CPM network diagram and bar chart - 15% of respondents

5. (Continued)

    d. Printouts by early start sequence alone - 14% of respondents

    e. CPM network diagram with bar chart - 13% of respondents

    f. Printouts by early start sequence with CPM network diagram - 10% of respondents

(Other combinations were reported but not in sufficient numbers to analyze).

6. The extent of the Superintendent's input to the development of the project work schedule was compared with the overall success of the CPM system.

    a. Major or moderate input by the Superintendent directly corresponds with successful systems

    b. CPM systems with major or moderate input by the Superintendent are used more frequently by the Superintendent

    c. Frequent use of the CPM system by the Superintendent correlates with successful systems

7. According to the general contractors who use CPM, the following user frequencies were found for personnel who make daily or weekly decisions based on the CPM data:

    a. Project Manager - "frequent user"

    b. Superintendent - "occasional user"

    c. Subcontractor - "rare user"

8. Success and failure factors concerning the use of CPM are characterized by the following comments:

    a. Understandability of printout data was the most frequently cited success factor. (71%)

       Responsive computer service was ranked a close second.

    b. The most prevalent failure factor was the time and money

8. (Continued)

   required to maintain the CPM scheduling system. The second ranked failure factor was the lack of support for the system by the Superintendents.

9. Successful CPM scheduling systems are distinguished by the following qualities:

   a. Superintendents support the system
   b. Superintendents are trained to use the system
   c. Data printouts are understandable (easily read)
   d. Computer programs are flexible (changes in the work schedule or cost revisions are easily incorporated)
   e. Time and money required to support the system is reasonable
   f. Top management supports the system

10. From a consensus of the responses, the following specific information should be presented in a weekly or monthly Field Report for Project Superintendents:

    a. Detailed schedule of work for next 60 days - 66% of replies
    b. Early start sequence of activities with slack shown - 55% of replies
    c. Computer printed bar chart of work and material deliveries for next 60 days - 50% of replies
    d. Manpower required to meet the schedule by work activity - 48% of replies
    e. Manpower required to meet the schedule by subcontract responsibility - 46% of replies
    f. Grouping of activities by subcontract by responsibility - 45% of replies
    g. Detailed schedule of material deliveries for the next 60 days - 44% of replies

11. In addition to the specific information described above, some further features were suggested by the respondents.
    a. Capability to show actual versus projected work schedule in a computerized bar graph
    b. Summary bar charts showing progress to date, man-hours expended to date, and estimated man-hours to finish work
    c. Comparison of actual versus estimated unit costs by work activity
    d. Exception report showing items which are late starting
    e. Equipment required to meet schedule

This survey was designed to discover what role the Superintendent plays in a CPM scheduling system. It was found that he is a major contributory factor in the success of a scheduling system through his involvement with, and support of the system. The second aspect of the survey was to define a CPM report which would enhance the usefulness of the computerized schedule to the Superintendent. It was found that visual reports in conjunction with detailed printouts would be most popular. It is clear that the Superintendent's input to the work logic, training in the use of the CPM system, and support of the system are factors which cannot be overlooked if a CPM system is to be successfully implemented. A schedule system should be a positive assistance to the Superintendent and not just more paperwork. Some quotations by construction managers were taken from the survey, and they reveal that some existing CPM systems are still not functioning in a positive role.

1. "Computerization of CPM tends to degenerate job site communication and has not shown itself a successful aide in job site schedule supervision."
2. "Human resources are invariably more productive in other pursuits once the basic CPM has been developed."

3. "We have found CPM useful in planning projects at the start, but very unwieldy and time consuming to monitor and update."

APPENDIX B

Questionnaires for Initial Survey and Random Sample With Summaries of the Responses

Sample of Questionnaire on CPM Use in Building Construction

(Initial Survey)

Respondent's Name: ______________________________

Title: ______________________________

Phone Number: AC ______________________________

Company Name: ______________________________

Location: ______________________________

1. Which scheduling system do you use most often for building construction projects?

    ___A. Bar Charts

    ___B. Critical Path Methods (CPM)

    ___C. Other (Describe)

    ____

    ____

2. Indicate the minimum construction cost of a building project which would normally be scheduled using your CPM system.

    $______________________________

3. Who in your organization reads and implements the schedule data presented by the CPM printouts relating to daily or weekly work scheduling?

    ___A. Project Manager

    ___B. Project Superintendent

    ___C. Subcontractors

    ___D. Other (Describe)

    ____

4. How is CPM being applied to building construction projects in your company at the Superintendent level?

4. (Continued)

___A. Shop drawing and submittal control

___B. Control of subcontract awards

___C. Construction control of work and material delivery

___D. Construction control of project milestones

___E. Other (Describe)

____

____

____

____

5. How do your Project Superintendents receive schedule information for a typical building project. (A sample printout or brochure would be very useful if one can be sent. These samples would be kept confidential and not distributed).

___A. Printouts of scheduled activity start dates by early start sequence.

___B. Printouts of activities by subcontract responsibility.

___C. Limited "look ahead" schedule which only lists activities due to start in the next 30 or 60 days.

___D. Graphically

___i. CPM Network Diagram

___ii. Precedence Chart

___iii. Bar Chart

___iv. Other (Describe)

____

____

___E. Other (Describe)

____

____

____

6. To what extent do your Project Superintendents participate in the development of the project work schedule when CPM is used?

___Major input ___Minor input

___Moderate input ___No input

7. How often is CPM information used in making daily or weekly decisions concerning construction operations in your company?

	Frequent	Occasional	Rare	Never
A. Project Manager	____	____	____	____
B. Project Superintendent	____	____	____	____
C. Subcontractor	____	____	____	____

8. How successful has CPM been in reducing construction time; construction costs, and increasing company profits on your building projects? Circle "TIME," "COST," or "PROFIT" (or any combination of factors) to indicate your basis for evaluating success.

SUCCESSFUL			UNSUCCESSFUL	DON'T KNOW
VERY	MODERATELY	PARTIALLY		
____	____	____	____	____

9. What factors contribute to your success or failure in using CPM scheduling? Use an "S" for success factor and an "F" for failure factor.

___A. Responsive computer service
(i. e. speed of processing and accuracy of printout)

___B. Flexibility of computer program.
(i. e. ability to process revisions and changes)

___C. Understandability of printout data.
(i. e. can it be read and interpreted easily)

___D. Superintendents trained to use CPM system.

___E. Time and money required to keep the schedule current.

___F. Support of system by superintendents.

___G. Other (Describe).

____

____

____

10. What specific information would you want in a weekly or monthly Field

10. (Continued) Report for your Project Superintendents in order to increase their effectiveness and also to enhance the profitability of the project?

___A. Manpower required to meet the schedule by subcontract

___B. Manpower required to meet the schedule by individual work activity

___C. Quantities of material required for each work activity (i. e. 1000 LF of 1" conduit)

___D. Total quantity of material to be delivered by major classification of material. (i. e. 10" C.I.P.; 6" conduit)

___E. Detailed schedule of work for the next 60 days

___F. Detailed schedule of material delivery for the next 60 day period

___G. Early start date sequence of activities with slack shown

___H. Grouping of activities by subcontract responsibility

___I. Computer printed bar chart schedule of work and material deliveries for the next 60 day period

___J. Other (Describe)

____

____

____

Desired return date is 23 February 1976. Contact Mr. Neil Bromilow, P.E., (phone AC814-865-6394) if any clarification of questions is needed.

Please return to: Mr. Neil Bromilow, P.E.
Department of Architectural Engineering
The Pennsylvania State University
101 Engineering "A" Building
University Park, Pennsylvania 16802

Summary of Initial Questionnaire Responses

Question:	Total Replies per Question:
1. Which system used:	
a. Bar charts	33
b. CPM	46
c. Other	2
2. Minimum cost for CPM application (millions)	3.5 average
3. Who uses CPM:	
a. Project Mgr.	69
b. Project Supt.	66
c. Subcontractors	19
d. Other	12
4. How is CPM used:	
a. Shop drawings	30
b. Subcontract award	15
c. Control work and material	63
d. Project milestones	58
e. Other	12
5. What form is used:	
a. By start dates	42
b. By subcontract	19
c. 60 day look ahead	14
d. Graphically	
i. CPM	43
ii. Precedence	14
iii. Bar chart	40
iv. Other	4

Summary of Initial Questionnaire Responses (Continued)

Question:	Total Replies per Question:
5. (Continued)	
e. Other	3
6. Extent of Supt. input:	
a. Major	38
b. Moderate	33
c. Minor	6
d. None	2
7. Frequency of CPM use:	
a. Project Mgr.	Freq.-37, Occasion-28, Rare-9, None-3
b. Project Supt.	Freq.-30, Occasion-33, Rare-10, None-4
c. Subcontractor	Freq.-10, Occasion-21, Rare-30, None-6
8. How Successful:	
a. Very successful	Time-12, Cost-6, Profit-7
b. Moderately successful	Time-30, Cost-14, Profit-8
c. Partially successful	Time-10, Cost-1, Profit-2
d. Unsuccessful	Time-8, Cost-2, Profit-0
e. Don't know	18
9. Success factors:	
a. Computer service	Success-38, Failure-9
b. Computer program	Success-35, Failure-13
c. Understandability	Success-40, Failure-16
d. Training	Success-35, Failure-20
e. Time and money	Success-22, Failure-30
f. Support	Success-31, Failure-25
g. Other	Success-7, Failure-6

Summary of Initial Questionnaire Responses (Continued)

Question:		Total Replies per Question:
10. Desired report:		
a.	Manpower for subs.	37
b.	Manpower by work	38
c.	Quantity of material	18
d.	Total quantity of material	15
e.	Work for 60 days	53
f.	Material for 60 days	35
g.	Start dates	44
h.	Group by subs.	36
i.	Bar chart	40
j.	Other	16

Sample of Questionnaire on CPM Use in Building Construction

(Random Sample)

Respondent's Name: ______________________________

Title: ______________________________

Phone Number: AC ______________________________

Company Name: ______________________________

Location: ______________________________

1. Which scheduling system do you use most often for building construction

   ___A. Bar Chart

   ___B. Critical Path Methods (CPM)

   ___C. Other (Describe)

   ____

   ____

2. How successful has your CPM system been in reducing construction time; reducing construction costs, and increasing company profits on your building projects?

   Circle one or any combination of the following factors to indicate your basis for evaluating success.

SUCCESSFUL			UNSUCCESSFUL	DON'T KNOW
VERY	MODERATELY	PARTIALLY		
[TIME] [COST] [PROFIT]	[TIME] [COST] [PROFIT]	[TIME] [COST] [PROFIT]	[TIME] [COST] [PROFIT]	______

3. What factors contribute to your success or failure in using CPM scheduling? Circle the appropriate factors listed below.
   (An "S" indicates success and an "F" indicates failure).

   S F 1. Responsive computer service.
   (i. e. speed of processing and accuracy of printout).

   S F 2. Flexibility of computer program.
   (i. e. ability to process revisions and change orders).

3. (Continued)

S F 3. Understandability of printout data. (i. e. can it be read and interpreted easily).

S F 4. Superintendents trained to use CPM system.

S F 5. Time and money required to keep the schedule current.

S F 6. Support of the system by Superintendents.

S F 7. Other (Describe).

____

4. How do your Superintendents receive schedule information for a typical building project?

___A. Graphically

___i. Bar Chart

___ii. CPM Network Diagram

___iii. Precedence Diagram

___iv. Other (Describe)

____

5. To what extent do your Project Superintendents participate in the development of the project work schedule when CPM is used?

___Major input ___Minor input

___Moderate input ___No input

Desired return date is 14 May 1976. Contact Mr. Neil Bromilow, P.E. (phone AC 814-865-6394) if any clarification of the questions is needed.

Please return to: Mr. Neil Bromilow, P.E.
Department of Architectural Engineering
The Pennsylvania State University
101 Engineering "A" Building
University Park, PA 16802

NB/ek
4/22/76

Summary of Random Sample Questionnaire Responses

Question:	Total Replies per Question:
1. Which system used:	
a. Bar chart	3
b. CPM	3
c. Other	0
2. How successful:	
a. Very successful	Time-2, Cost-1, Profit-1
b. Moderately successful	Time-1, Cost-0, Profit-0
c. Partially successful	Time-0, Cost-1, Profit-0
d. Unsuccessful	Time-0, Cost-0, Profit-1
e. Don't know	3
3. Success factors:	
a. Computer service	Success-2, Failure-1
b. Computer program	Success-3, Failure-0
c. Understandability	Success-3, Failure-1
d. Training	Success-2, Failure-1
e. Time and money	Success-3, Failure-0
f. Support	Success-3, Failure-1
g. Other	Success-2, Failure-0
4. What form is used:	
a. Graphical	
i. Bar chart	3
ii. CPM	4
iii. Precedence	0
iv. Other	0
b. By start dates	3

Summary of Random Sample Questionnaire Responses (Continued)

Question:	Total Replies per Question:
4. (Continued)	
c. By subcontract	2
d. 60 day look ahead	1
e. Other	2
5. Extent of Supt. input:	
a. Major	2
b. Moderate	0
c. Minor	1
d. None	1

APPENDIX C

Formats and Descriptions of the Output Reports:

1. Weekly Cost Analysis
2. Milestones/Logic Diagram
3. Cover Page
4. Monthly Summary
5. Chart of Scheduled Work
6. Chart of Scheduled Material
7. Trade List of Material and Work

```
                    1                                                   2
DATE OF DATA:  XX/XXX/XX ** WEEKLY COST ANALYSIS       ** DATE PRINTED:  XX/XXX/XX
PROJECT NAME:  XXXXXXX 3  XXXXXXXX CONTR:  XXXXXXXX 4 XXXXXXXX  PAGE:  XXXX
PROJECT LOCAT:  XXXXXX 6  XXXXXXXXX OWNER:  XXXXXXXX 7 XXXXXXXX          5
REPORT FOR PERIOD FROM XX/XXX/XX TO XX/XXX/XX
                          8
                   *  OVERRUN ITEMS  *  (5% OR MORE OVER COST)
                               9
*********************************************************************************

CODE NO. DESCRIPTION      NO. DESCRIPTION  %  ACTUAL COST OVER
                AREA                          ESTIMATED COST        %    INDICATED

 I    J                                    COM  LABOR  MAT'L  EQUIP   OVER  OUTCOME

XXXX XXXX XXXXXXXXXXXXXX  XX  XXXXXXXXXXX XXX  XX,XXX XX,XXX XX,XXX  XXX    XX,XXX
                    XXXX                       XX,XXX XX,XXX XX,XXX
   10          11          12        13        14    15     16     17     18      19
                  *  UNDERCOST ITEMS  *  (5% OR MORE UNDER COST)
                              20
            (SAME SUBHEADINGS AS THE OVERRUN ITEMS EXCEPT AS NOTED)

                                                             %
                                                             UNDR
```

DESCRIPTION OF WEEKLY COST ANALYSIS

Item No.	Definition
1	DATE OF DATA - Day/Month/Year that supporting data were collected.
2	DATE PRINTED - Day/Month/Year that report was printed.
3	PROJECT TITLE - Specific title of job.
4	CONTRACTOR - Name of prime contractor.
5	PAGE - Consecutive numbering of all pages in the report.
6	LOCATION - Specific location of job.
7	OWNER - Name of owner.
8	REPORT FOR PERIOD FROM __ TO __ - Inclusive dates for report.
9	OVERRUN ITEMS - Listing of all prime contractor Items which are 5% or more over the estimate. Percentage can be varied as desired.
10	ACTIVITY/CODE NO. - Network I and J numbers for each ACTIVITY.
11	ACTIVITY DESCRIPTION/AREA - Brief description of work activity, and work location in building.
12	ITEM NO. - Unique number for each Item listed under an Activity.
13	ITEM DESCRIPTION - Brief definition of Item.
14	% COMPLETE - Percentage of Item completion taken from the Superintendent's Weekly Progress Report. If the input is in units of days remaining, then the computer will calculate a percentage by dividing the elapsed time since the Item was begun by the new duration.
15, 16 & 17	ACTUAL COST OVER ESTIMATED COST - For each of the three cost categories: labor; material; and equipment; the actual cost to date is shown over the estimated cost. The

DESCRIPTION OF WEEKLY COST ANALYSIS (Continued)

Item No.	Definition
15, 16 & 17	(Continued) Superintendent's Daily Report provides the individual charges and the computer totals them by Item number.
18	% OVER COST - Percentage that an Item is in excess of the estimate. Actual costs to date are totaled and a revised unit cost is calculated. This is divided by the original unit cost and the percent variation is found. Items are ranked in descending order of this percent variation.
19	INDICATED OUTCOME - Dollar value of loss or gain if corrective action is not taken. The difference between the original unit cost and the revised unit cost is multiplied by the quantity of remaining work.
20	UNDER COST ITEMS - Listing of all prime contractor Items which are 5% or more under the estimated cost. All subheadings are the same as those in the OVERRUN ITEM listing except the percent over cost column is labeled percent "under cost."

```
                    1                                                       2
DATE OF DATA:  XX/XXX/XX ** MILESTONES/LOGIC DIAGRAM  **  DATE PRINTED:  XX/XXX/XX

PROJECT NAME:  XXXXXXXX 3 XXXXXXXX CONTR:  XXXXXXXX 4 XXXXXX   PAGE:  XXXX
                                                                        5
              *  ACTIVITIES RANKED BY XXXXX 6 XXXX *

*********************************************************************

      ACTIVITY                         TIME SCALE IN XXXXXXXXXXX

CODE NO.  DESCRIPTION
                    XX/XX XX/XX XX/XX XX/XX XX/XX XX/XX XX/XX XX/XX XX/XX
  I   J            +     +     +     +     +     +     +     +     +     +

XXXX XXXX XXXXXXXXXXXXXX
   7          8                         9
```

DESCRIPTION OF MILESTONE/LOGIC DIAGRAM

Item No.	Definition
1	DATE OF DATA - Day/Month/Year that supporting data was collected.
2	DATE PRINTED - Day/Month/Year that report was printed.
3	PROJECT NAME - Specific title of job.
4	CONTRACTOR - Name of prime contractor
5	PAGE - Consecutive numbering through all reports in the monthly listing.
6	ACTIVITIES RANKED BY - Indicates method of ordering Activities, such as by descending criticality, or by work area.
7	ACTIVITY CODE NO./ I J - Unique number for each Activity.
8	DESCRIPTION - Brief definition of Activity.
9	TIME SCALE - Any period in the contract time either months or weeks. Usually the milestones and a few key Activities are listed to provide an overview of the project.

```
                  1                                                       2
DATE OF DATA:   XX/XXX/XX  **        COVER PAGE        **  DATE PRINTED:  XX/XXX/XX
PROJECT NAME:   XXXXXXXX 3 XXXXXXX    CONTR:  XXXXXXX 4 XXXXXXXXX   PAGE:  XXXX
                                                                            5
*************************************************************************************

PROJECT LOCATION:  XXXXXXXXXXXXXXXXXXXXXXXX 6
           OWNER:  XXXXXXXXXXXXXXXXXXXXXXXX 7
LATEST CHANGE ORDER PROCESSED:  XXX 8
CONTRACT COMPLETION DATE:  XX/XXX/XX 9
PROJECTED COMPLETION DATE:  XX/XXX/XX 10
CALENDAR DAYS AHEAD (+) OR BEHIND (-) SCHEDULE:  XXXX 11

                          **    TABLE OF CONTENTS    **

REPORT TITLE:                                                     PAGE NO.
    12                                                               13
MONTHLY SUMMARY-------------------------------------------------    XXX
CHART OF SCHEDULED WORK-----------------------------------------    XXX
CHART OF SCHEDULED MATERIAL DELIVERY----------------------------    XXX
TRADE LIST OF MATERIAL AND WORK ACTIVITIES----------------------    XXX
```

DESCRIPTION OF MONTHLY COVER PAGE

Item No.

Item No.	Description
1	DATE OF DATA - Day/Month/Year that the supporting data were collected.
2	DATE PRINTED - Day/Month/Year that report was printed.
3	PROJECT NAME - Specific title of job.
4	CONTRACTOR - Name of general contractor.
5	PAGE - Consecutive numbering through all reports in the monthly listing.
6	LOCATION - Specific location of job.
7	OWNER - Name of owner.
8	LATEST CHANGE ORDER PROCESSED - Number of the last change order included in the schedule.
9	CONTRACT COMPLETION DATE - Contractural date of completion including all change orders.
10	PROJECTED COMPLETION DATE - Scheduled completion date of work based on current progress data.
11	CALENDAR DAYS AHEAD (+) OR BEHIND (-) SCHEDULE - Difference between the scheduled completion date and the contract completion date.
12	REPORT TITLE - Description of reports included in the printout.
13	PAGE NO. - Page number corresponding to the reports in the printout.

```
                 1                                                      2
DATE OF DATA:  XX/XXX/XX  **    MONTHLY SUMMARY      **  DATE PRINTED:  XX/XXX/XX
PROJECT NAME:  XXXXXXXX 3 XXXXXXX  CONTR:  XXXXXXXX 4 XXXXXXX  PAGE:  XXXX
                                                                       5
***********************************************************************************

WORK IN PLACE SINCE XX/XXX/XX: $ XXX,XXX,XXX 6
MATERIAL DELIVERED SINCE XX/XXX/XX:  $ XXX,XXX,XXX 7
TOTAL PERCENTAGE OF WORK COMPLETE:  XXX % 8
TOTAL PAYMENT DUE THIS PERIOD LESS XXX % FOR RETENTION:  $ XXX,XXX,XXX 9 10
TOTAL CONTRACT VALUE THROUGH CHANGE ORDER NO. XXX IS:  $ XXX,XXX,XXX 11 12
PROJECTED PAYMENT FOR NEXT 30 DAY PERIOD LESS XXX % FOR RETENTION:  $ XXX,XXX,XXX
                                               13                        14

                    **    TRADE REQUIREMENTS    **
                               15
TRADE   TOTAL           TRADE REQUIREMENTS FOR NEXT 60 DAYS BY WEEK

        MANDAYS   XX/XX XX/XX XX/XX XX/XX XX/XX XX/XX XX/XX XX/XX XX/XX XX/XX
                 +     +     +     +     +     +     +     +     +     +     +
XX      XXXXX      XXX   XXX   XXX   XXX   XXX   XXX   XXX   XXX   XXX   XXX
16      17                               18
                    **    EQUIP. REQUIREMENTS    **
                                 19
EQUIP.   TOTAL            MAJOR EQUIPMENT FOR NEXT 60 DAYS BY WEEK

NAME     HOURS   XX/XX XX/XX XX/XX XX/XX XX/XX XX/XX XX/XX XX/XX XX/XX XX/XX
                +     +     +     +     +     +     +     +     +     +     +
XXXXXXXX XXXX     XXX   XXX   XXX   XXX   XXX   XXX   XXX   XXX   XXX   XXX
  20      21                            22
```

DESCRIPTION OF MONTHLY SUMMARY

Item No.	Definition
1	DATE OF DATA - Day/Month/Year that supporting data were collected.
2	DATE PRINTED - Day/Month/Year that report was printed.
3	PROJECT NAME - Specific title of job.
4	CONTRACTOR - Name of prime contractor.
5	PAGE - Consecutive numbering through all reports in monthly printout.
6	WORK IN PLACE THIS PERIOD - Dollar value of completed work in previous 30 calendar day period. Only labor and equipment costs are included. Quantities are taken from the Superintendent's Daily Report and then multiplied by the appropriate unit costs.
7	MATERIAL DELIVERED THIS PERIOD - Dollar value of material delivered in the prior 30 calendar day period. Both material in place and material stored on site are included. The quantities are taken from the Superintendent's Daily Report and the unit costs come from the Purchasing Agent's Weekly Report.
8	TOTAL PERCENTAGE COMPLETE - Calculated by dividing the labor and equipment costs to date by the contract price. The contract price is reduced by the material costs before dividing.
9 & 10	TOTAL PAYMENT DUE THIS PERIOD LESS ___% FOR RETENTION - Money due contractor less a specified percentage for retention. Value is found by adding the monthly work in place to the material delivered for the month.

DESCRIPTION OF MONTHLY SUMMARY (Continued)

Item No.	Definition
11 & 12	TOTAL CONTRACT VALUE THROUGH CHANGE NO. - Revised total cost of contract including all processed change orders. The processed changes are reported by the Accounting Department.
13 & 14	PROJECTED PAYMENT DUE FOR NEXT 30 DAY PERIOD LESS ___% FOR RETENTION - Anticipated payment to contractor if schedule is maintained. The computer totals all activities scheduled to be active in the next 30 day period and computes a projected income based on an assumed linear production rate. (i. e. if 20% of the Activity duration will elapse then 20% of the work will be done).
15	TRADE REQUIREMENTS FOR NEXT 60 CALENDAR DAYS - Summary table of manhours required for each contractor.
16	TRADE - Name of party performing work in the next 60 calendar days. Prime contractor is listed first, then subcontractors in alphabetic order.
17	TOTAL MANDAYS REQUIRED - For each trade working in the next 60 days, the mandays required to meet the schedule are indicated. Quantities are taken from the labor hours estimated for each Item and totaled by trade. If subcontractor mandays are not known, then the printed printout will show an "X" where the manhours should be. This will indicate that some work is to be done by a certain subcontractor.
18	TIME SCALE - Mandays required to meet the schedule are identified for each trade by the week. The date of each Monday is entered as the column heading.

DESCRIPTION OF MONTHLY SUMMARY (Continued)

Item No.	Definition
19	MAJOR EQUIPMENT REQUIRED FOR NEXT 60 CALENDAR DAYS - Tabular summary of equipment needs on a time scale. The Scheduler and Superintendent create this list for each phase of the project.
20	EQUIPMENT NAME - Specific type of equipment.
21	HOURS REQUIRED - Estimated usage of equipment.
22	TIME SCALE - Hours of equipment time required to meet the schedule are indicated by week. This is accomplished by associating an Activity-Item number with a given piece of equipment.

```
                  (1)                                                    (2)
DATE OF DATA:   XX/XXX/XX  **  CHART OF SCHEDULED WORK    **  DATE PRINTED:  XX/XXX/XX
PROJECT NAME:   XXXXXXXX (3) XXXXXXXXX  CONTR:  XXXXXXXX(4)XXXXXXXX   PAGE:  XXXX
                                                                              (5)
      *  CRITICAL ACTIVITIES BY EARLY START  *      KEY:  I#            J#
                       (7)                                VVVVVVVVVVVVVVV - PLANNED
                                                                 (6)
*****************************************************************************************

ACTIVITY DESCP TR DUR. TOTAL   TIME SCALE FOR 60 DAYS BY WEEK                    CONT
                             XX/XXXX/XXXX/XXXX/XXXX/XXXX/XXXX/XXXX/XXXX/XX
          AREA   WDAY  SLACK +    +    +    +    +    +    +    +    +    +      WDAY
XXXXXXXXXXXXXX XX XXXX XXXX  I            J                                    XXXX
          XXXX               VVVVVVVVVVVVVV
       (8)     (9) (10) (11)               (12)                                (13)

                                * NEAR CRITICAL ACTIVITIES BY EARLY START *
                             (14) (WITHIN 30 DAYS OF THE CRITICAL PATH)

                                  (SAME SUBHEADINGS AS THE CRITICAL LIST)

                                * OTHER ACTIVITIES BY EARLY START *

                             (15) (SAME SUBHEADINGS AS THE CRITICAL LIST)
```

DESCRIPTION OF MONTHLY CHART OF SCHEDULED WORK

Item No.	Definition
1	DATE OF DATA - Day/Month/Year that supporting data were collected.
2	DATE PRINTED - Day/Month/Year that report was printed.
3	PROJECT NAME - Specific title of job.
4	CONTRACTOR - Name of prime contractor.
5	PAGE - Consecutive numbering through all reports in monthly listing.
6	KEY TO CHART - Indicates meaning of the bar chart characters.
7	CRITICAL ACTIVITIES - All work activities on the critical path for both Prime and Subcontractors.
8	ACTIVITY DESCRIPTION _ Brief definition of work activity.
9	TRADE RESPONSIBILITY - Code work for party responsibility for accomplishing work. (i. e. General Contractor - GC)
10	DURATION/WORK DAY - Time required to complete Activity.
11	TOTAL SLACK - Number of work days ahead or behind schedule.
12	TIME SCALE - The forthcoming 60 calendar day period divided into weeks. Column headings are the date in Days/Month of each Monday. Activities are listed by Early Start sequence in ascending order of the 'I' number. "Dummy" Activities are shown with a single "0" for the duration symbol instead of the usual "V" symbol. The "I-J" number is printed above the "0" the same as a work or material Activity.
13	CONTINUE ACTIVITY/WORK DAY - Activities which exceed the 60 calendar day period without being complete are indicated by the number of work days outstanding.

DESCRIPTION OF MONTHLY CHART OF SCHEDULED WORK (Continued)

Item No.	Definition
14	NEAR CRITICAL ACTIVITIES - Activities with a Total Slack of 30 days or less are listed under this heading with the same subheadings as the Critical Activity List.
15	OTHER ACTIVITIES - Activities with a Total Slack of more than 30 days are listed under this heading with the same subheadings as the Critical Activity List.

```
              1                                                        2
DATE OF DATA:  XX/XXX/XX  **  CHART OF SCHEDULED MATERIAL  **  DATE PRINTED:  XX/XXX/XX
PROJECT NAME:  XXXXXXXX 3 XXXXXXXXXX CONTR:  XXXXXXXXX 4 XXXXXXXXXX  PAGE:  XXXX
                                                                             5
     *  CRITICAL DELIVERIES BY EARLY START  *    KEY:  I#              J#
                          7                            VVVVVVVVVVVVVVVV - PLANNED
                                                               6
*************************************************************************************

ACTIVITY DESCP TR DUR. TOTAL   TIME SCALE FOR 60 DAYS BY WEEK                  CONT
                              XX/XXXX/XXXX/XXXX/XXXX/XXXX/XXXX/XXXX/XXXX/XX
          TYPE   WDAY  SLACK +    +    +    +    +    +    +    +    +    +        WDAY

XXXXXXXXXXXXXX XX XXXX XXXX  I                  J
          XXXX               VVVVVVVVVVVVVVVVVVV                                   13
       8      9   10   11                       12
                *  NEAR CRITICAL DELIVERIES BY EARLY START  *

             14 (SAME SUBHEADINGS AS THE CRITICAL LIST)

                *  OTHER MATERIAL DELIVERIES BY EARLY START  *

             15 (SAME SUBHEADINGS AS THE CRITICAL LIST)
```

DESCRIPTION OF MONTHLY CHART OF MATERIAL DELIVERIES

Item No.	Definition
1	DATE OF DATA - Day/Month/Year that supporting data were collected.
2	DATE PRINTED - Day/Month/Year that report was printed.
3	PROJECT NAME - Specific title of job.
4	CONTRACTOR - Name of prime contractor.
5	PAGE - Consecutive numbering through all reports in monthly listing.
6	KEY TO CHART - Indicates meaning of bar chart characters.
7	CRITICAL MATERIAL - All material activities on the critical path for both Prime and Subcontractors
8	ACTIVITY DESCRIPTION/TYPE - Brief description of material and the word "MAT'L" is shown to indicate the TYPE.
9	TRADE RESPONSIBILITY - Code work for party responsibility for acquiring material. (i. e. Electrical Subcontractor - EL)
10	DURATION/WORK DAY - Time required to complete Activity.
11	TOTAL SLACK - Number of work days ahead or behind schedule.
12	TIME SCALE - The forthcomgin 60 calendar day period divided into weeks. Activities are listed by Early Start sequence in ascending order of the 'I' number. "Dummy" Activities are shown by the symbol of a single "O" with the "I-J" number above it.
13	CONTINUE ACTIVITY/WORK DAY - Activities which exceed the 60 calendar day period without being complete are designated by the number of work days outstanding.
14	NEAR CRITICAL MATERIAL - Activities with a Total Slack of 30

DESCRIPTION OF MONTHLY CHART OF MATERIAL DELIVERIES (Continued)

Item No.	Definition
14	(Continued) days or less are listed under this heading with the same subheadings as the Critical Material List.
15	OTHER MATERIAL - Activities with a Total Slack of more than 30 days are listed under this heading with the same subheadings as the Critical Material List.

```
                1                                                             2
DATE OF DATA:   XX/XXX/XXX  **  TRADE LIST OF MATERIAL & WORK  **  DATE PRINTED:  XX/XXX/XX
PROJECT NAME:   XXXXXXXX 3  XXXXXXXXXX CONTR:  XXXXXXXXXX 4 XXXXXXXXXX  PAGE:  XXXX
                                                                                 5
                       *  RESPONSIBILITY TRADE:  XXXXXXXXXX  *
                                                    6
****************************************************************************************

CODE NO.  ACTIVITY DESCR   DUR. COST     WORK EARLY   EARLY   TOTAL
 I    J                    WDAY   $      AREA START   FINISH  SLACK
XXXX XXXX XXXXXXXXXXXXXX   XXXX  XXX,XXX XXXX XXXXXXX XXXXXXX XXXX
  7            8            9      10     11     12      13     14
     ITEM ITEM           QTY     UNIT          ESTIMATE                UPDATE
      NO. DESCRIPTION                 LABOR LABOR  MAT'L  EQUIP      %     OR WDAYS
                                       HRS   COST   COST   COST    COMPL      REMAINING
     XXX  XXXXXXXXXXXX XX,XXX  XXXX   XXXXX XX,XXX XX,XXX XX,XXX   XXX          XXX
      15       16        17     18      19    20     21     22      23           24
```

DESCRIPTION OF MONTHLY LIST OF MATERIAL AND WORK ACTIVITIES

Item No.	Definition
1	DATE OF DATA - Day/Month/Year that supporting data were collected.
2	DATE PRINTED - Day/Month/Year that report was printed.
3	PROJECT NAME - Specific title of job.
4	CONTRACTOR - Name of prime contractor.
5	PAGE - Consecutive numbering through all reports in monthly listing.
6	RESPONSIBLE TRADE - Name of party responsible for accomplishing the work. Prime contractor listed first then subcontractors in alphabetic order.
7	CODE NO./ I J - Unique number for each ACTIVITY taken from the CPM Network Diagram. Activities are listed by Early Start Date then by 'I' number in ascending order.
8	ACTIVITY DESCRIPTION - Brief definition of Activity. All material activities are listed before any work activities.
9	DURATION/WORK DAY - Time required to complete Activity.
10	COST/ $ - Total cost of Activity.
11	WORK AREA - Specific location within job site where work is to be done. (i. e. Ground Floor West Wing - GFWE)
12	EARLY START - Earliest possible starting date for Activity. (Day/Month/Year)
13	EARLY FINISH - Earliest possible finishing date for Activity. (Day/Month/Year)
14	TOTAL SCLAK - Number of working days ahead or behind schedule.

DESCRIPTION OF MONTHLY LIST OF MATERIAL AND WORK ACTIVITIES (Continued)

Item No.	Definition
15	ITEM NO. - Unique number for each Item listed under an Activity. Several Items can be grouped under one Activity.
16	ITEM DESCRIPTION - Brief definition of Item. Material Activities will have four Items. These are: submission of drawings (SUB): approval of drawings (APP); fabrication of material (FAB); and delivery of material (DEL). Work Activities will have sufficient Items to provide detailed cost analysis. For example, an Activity titled "Concrete Columns" could have the following Items: "Forming," "Pouring," Curing," and "Stripping." Except for Material Activities, subcontractors will not usually have any Items.
17	QUANTITY - Numerical value of Item.
18	UNITS - Unit of measure of Item. (i. e. Cubic yards - C. Y.) Material Activities will have the number of working days duration for the submission, approval, and fabrication Items, but the delivery Item will be in measurement units compatible with the material. (i. e. Electrical conduit measured in linear feet - L. F.)
19	ESTIMATE/LABOR HOURS - Total manhours required for the Item.
20	ESTIMATE/LABOR COST - Total funds allowed for Item labor costs. For Material Items, any charges for labor to unload or store material is shown here.
21	ESTIMATE/MATERIAL COST - Total funds allowed for Itam material costs.
22	ESTIMATE/EQUIPMENT COST - Total funds allowed for Item equipment

DESCRIPTION OF MONTHLY LIST OF MATERIAL AND WORK ACTIVITIES (Continued)

Item No.	Definition
22	ESTIMATE/EQUIPMENT COST (Continued) - costs. For Material Items, any charges for equipment to unload or move material is shown here.
23	UPDATE/% COMPLETE - Estimate of percentage of Item completion. Filled in manually by Superintendent on a weekly basis.
24	UPDATE/WORK DAYS REMAINING - Instead of estimating a percent for completion the Superintendent can estimate the number of work days to finish the Item. Filled in manually by Superintendent on a weekly basis.

APPENDIX D

Formats and Descriptions of the Input Reports:

1. Superintendent's Daily
2. Superintendent's Weekly Progress Report
3. Weekly Salaried Personnel/Support Equipment Report
4. Weekly Purchasing Report

1	EIJ CORPORATION	2
PROJECT NO.		REPORT NO.

SUPERINTENDENT'S DAILY REPORT

3	4	5 DATE
PROJ. NAME & LOCATION	WEATHER	6 :8AM :4PM TEMPERATURE

A. EIJ LABOR: (HOURLY ONLY) HOURS BY ACTIVITY - ITEM #

	EMPLOYEE NAME	BADGE NO.	CLASS	10					REMARKS*
1.	7	8	9						11
2.									
3.									
4.									
5.									
6.									
7.									
8.									
9.									
10.									
11.									
12.									
13.									
14.									
15.									
16.									
17.									
18.									
19.									
20.									

AN (*) DENOTES OVERTIME

B. EIJ MATERIAL DELIVERED: (ATTACH DELIVERY RECEIPTS)

	DESCRIPTION	QTY	UNIT	ACTIVITY-ITEM #	P. O. NUMBER
1.	12	13	14	15	16
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					

C. EIJ EQUIPMENT: HOURS USED BY ACTIVITY-ITEM

	TYPE	EQUIP. #	19							IDLE	MAINT.
1.	17	18								20	21
2.											
3.											
4.											
5.											
6.											
7.											
8.											
9.											

D. SUBCONTRACTORS WORK:

	COMPANY NAME	TRADE	MEN	WORK PERFORMED
1.	22	23	24	25
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

E. TESTS PERFORMED/RESULTS:

1. 26
2.
3.
4.
5.
6.

F. COMMENTS: (VISITORS, ACCIDENTS, VERBAL DIRECTIONS, ETC.)

27

SUPERINTENDENT'S SIGNATURE

DESCRIPTION OF SUPERINTENDENT'S DAILY REPORT

Item No.	Definition
1	PROJECT NO. - Unique number for each job composed of a sequential number and the last two digits of the year in which the contract was awarded. (i. e. Third contract of 1976 would be 3-76)
2	REPORT NO. - Sequential number of reports from beginning of field work.
3	PROJECT NAME AND LOCATION - Specific title of job and location.
4	WEATHER - Brief description of weather. (i. e. Windy, or Heavy Rain)
5	DATE - Day/Month/Year of day being reported.
6	TEMPERATURE 8AM/4PM - Drybulb temperature at work site for the specified times.
7	EMPLOYEE NAME - First initial last name of each hourly worker employed by prime contractor.
8	BADGE No. _ Unique identification number assigned by Payroll Department for each prime contractor employee. Social Security number can be used.
9	CLASS - Work classification of each employee. (i. e. Ironworker - IRON, Laborer - LABR, Carpenter - CARP)
10	HOURS BY ACTIVITY - ITEM NO. - For each worker report the number of hours worked on specific Activity-Items for that day. Use the "List of Material and Work Activities" to find the proper number. Overtime is denoted by an asterisk.
11	REMARKS - Note any unusual employee problems such as being

DESCRIPTION OF SUPERINTENDENT'S DAILY REPORT (Continued)

Item No.	Definition
11	REMARKS (Continued) late or being sent home.
12	DESCRIPTION - Brief definition of material delivered. (i. e. ½" Plywood)
13	QUANTITY - Volume or length of material as a numerical value.
14	UNITS - Standard unit of measure for material. See "List of Material and Work Activities Report" for proper units.
15	ACTIVITY-ITEM NO. - The appropriate Activity-Item number is taken from the "List of Material and Work Activities Report." Material which is consumed upon delivery such as concrete is charged to the Work Item. (i. e. Pour concrete) Other material is charged to a Material Delivery Item.
16	PURCHASE ORDER NUMBER - Purchase order number taken from the delivery ticket.
17	TYPE - General description of equipment used. (i. e. 10T Crane)
18	EQUIPMENT NO. - Unique identification number assigned to each piece of equipment. If rental equipment is used, then the license number is entered.
19	HOURS USED BY ACTIVITY-ITEM NO. - For eace piece of equipment report the number of hours worked on specific Activity-Items for the day.
20	IDLE - For each piece of equipment report the number of hours it was not used.
21	MAINTENANCE - For each piece of equipment report the number of hours it was not working due to maintenance.
22	COMPANY NAME - Brief name of each subcontractor.

DESCRIPTION OF SUPERINTENDENT'S DAILY REPORT (Continued)

Item No.	Definition
23	TRADE - Short description of each subcontractor. (i. e. Painter - PA)
24	TOTAL MEN - For each subcontractor indicate the number of men working on the site.
25	WORK PERFORMED - Brief summary of each subcontractor's work for the day. (i. e. Painting First Floor)
26	TESTS PERFORMED/RESULTS - Note any tests taken or results of tests.
27	COMMENTS - Indicate any other information related to the job such as visitors and accidents.

(1) PROJECT NO.

EIJ CORPORATION

(2) / / WEEK ENDING

WEEKLY PROGRESS REPORT BY SUPT.

(3) PROJECT NAME & LOCATION

NOTE: A COPY OF THE "LIST OF MAT'L AND WORK REPORT" MAY BE ATTACHED IF UPDATE DATA IS MARKED IN RED.

A. EIJ WORK ACCOMPLISHED:

ACTIVITY-ITEM	WORK DAYS REMAINING	OR	PERCENT COMPLETE	REMARKS*
1. (4)	(5)		(6)	(7)
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

*DESCRIBE ANY MAJOR DEVIATIONS FROM THE SCHEDULE, OTHERWISE USE THE COMPUTER PRINTOUT FOR THIS SECTION.

B. SUBCONTRACTOR WORK ACCOMPLISHED:

ACTIVITY-ITEM	WORK DAYS REMAINING	OR	PERCENT COMPLETE	TRADE	REMARKS*
1. (8)	(9)		(10)	(11)	(12)
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					
13.					
14.					
15.					
16.					
17.					
18.					
19.					
20.					
21.					
22.					
23.					
24.					
25.					

C. COMMENTS: 13

SUPERINTENDENT'S SIGNATURE

DESCRIPTION OF SUPERINTENDENT'S WEEKLY PROGRESS REPORT

Item No.	Definition
1	PROJECT NO. - Unique number for each job composed of a sequential number and the last two digits of the year in which the contract was awarded.
2	WEEK ENDING - Day/Month/Year for the last day worked in the week.
3	PROJECT NAME AND LOCATION - Specific job title and location.
4	ACTIVITY-ITEM NO. - Indicate the Activity-Item number for the Items in progress during the past week. Use this section only if clarifying remarks are needed. Otherwise attach a copy of the "List of Material and Work Activities Report" with the update date marked in red.
5	WORKDAYS REMAINING - Enter an estimate of the workdays needed to complete the Item.
6	PERCENT COMPLETE - Instead of entering the workdays remaining indicate a percentage of Item completion.
7	REMARKS - Explain any significant delays or revisions to the schedule.
8, 9 & 10	Same information as described above for sections 4, 5, & 6 except these Items will be subcontractor's work
11	TRADE - Short description of subcontractor. (i. e. Mason - MA)
12	REMARKS - Explain any significant delays or revisions to the schedule.
13	COMMENTS - Additional space for sections 7 and 12.

1 EIJ CORPORATION 2

______ / / ______

PROJECT NO. DATE

WEEKLY SALARIED PERSONNEL/SUPPORT EQUIPMENT REPORT

3

PROJECT NAME & LOCATION

A. EIJ PERSONNEL: (SALARIED ONLY)

					6 HOURS*			
NAME	TITLE	M	T	W	TH	F	S	S
1. 4	5							
2.								
3.								
4.								
5.								
6.								
7.								
8.								
9.								
10.								

* H-HOLIDAY; S-SICK; A-ANNUAL LEAVE; U-UNACCOUNTED ABSENT

B. EIJ SUPPORT EQUIPMENT: (OFFICE TRAILERS, ETC.)

DESCRIPTION	EQUIPMENT #	TOTAL HOURS ON SITE
1. 7	8	9
2.		
3.		
4.		
5.		

SUPERINTENDENT'S SIGNATURE

DESCRIPTION OF WEEKLY SALARIED PERSONNEL AND SUPPORT EQUIPMENT REPORT

Item No.	Definition
1	PROJECT NO. - Unique number for each job composed of a sequential number and the last two digits of the year in which the contract was awarded.
2	DATE - Day/Month/Year of the last day in report period.
3	PROJECT NAME & LOCATION - Specific title and location of work site.
4	NAME - Full name of each salaried employee of the prime contractor assigned to the project.
5	TITLE - Organizational position of each salaried prime contractor employee assigned to the field office.
6	HOURS - Weekly summary of the daily work including any leave or sick time.
7	DESCRIPTION - Brief definition of the support equipment. (i. e. Office trailer)
8	EQUIPMENT NO. - Unique identification number for each piece of equipment.
9	TOTAL HOURS - Total time that each piece of equipment was on the job site for reporting period.

1	EIJ CORPORATION	2
PROJECT NO.		WEEK ENDING

WEEKLY PURCHASING REPORT

3
PROJECT NAME & LOCATION

A. MATERIAL ORDERED:

	TYPE	QTY. UNITS	TOT. COST UNIT COST	DIS.	DEL. DATE	P.O. NO.	ACTIVITY-ITEM NO.
1.	XXXXXXXXXXX XXXXXXXXXXX	XXXXXX XXXX	XXX,XXX XXX,XXX	XXX XXX	XXXXXXX	XXXX	XXXX-XXXX XX
2.	4	5	6	7	8	9	10
3.							
4.							
5.							
6.							
7.							
8.							
9.							
10.							
11.							
12.							
13.							
14.							
15.							
16.							
17.							
18.							
19.							
20.							
21.							
22.							
23.							
24.							

B. SUBCONTRACTS AWARDED:

	COMPANY NAME	TRADE	TOTAL COST	START DATE
1.	11	12	13	14
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

C. COMMENTS: 15

PURCHASING AGENT

DESCRIPTION OF PURCHASING AGENT'S WEEKLY REPORT

Item No.	Definition
1	PROJECT NO. - Unique number for each job composed of a sequential number and the last two digits of the year in which the contract was awarded.
2	WEEK ENDING - Day/Month/Year of last day in report period.
3	PROJECT NAME & LOCATION - Specific title of job and location.
4	TYPE - Brief description of material including size. (i. e. ½" FRP)
5	QTY/UNITS - Quantity of material over the unit of measure, such as SF or CY.
6	TOT. COST/UNIT COST - Total material cost over the unit cost.
7	DIS - Discount or terms of payment such as 10% discount if payed within 30 days of invoice. (coded for brevity to read 10%/30D)
8	DEL DATE - Day/Month/Year of anticipated delivery.
9	P. O. NO. - Purchase order number for the material.
10	ACTIVITY-ITEM NUMBER - For each type of material or group of material types assign an Activity-Item number from the schedule. Direct use material such as concrete will be assigned an Item number for "Pouring," while a delayed use material such as rebar will be assigned an Item number for "Delivery."
11	COMPANY NAME - Specific name of each subcontractor.
12	TRADE - Short description of each subcontractor's work. (i. e. Mason - MA)
13	TOTAL COST - Value of each subcontract.
14	START DATE - Day/Month/Year that subcontractor is required to

DESCRIPTION OF PURCHASING AGENT'S WEEKLY REPORT (Continued)

Item No.	Definition
14	START DATE - (Continued) start work.
15	COMMENTS - Any additional information which should be recorded such as delays in receiving approval to order materials.

APPENDIX E

Utilization of Input Data and Procedures for Calculating Output Data

UTILIZATION OF INPUT DATA AND PROCEDURES FOR CALCULATING OUTPUT DATA

Input		Output/Calculation
* Daily Report *		
Item No.	Description	
1 thru 7	Proj. No. Temp.	-Administrative data not entered into the computer, but kept for the record.
8 & 9	Badge No. Class.	-Wage rates are keyed internally in the computer to these two items.
10	Hours	- The actual labor cost for the Weekly Cost Analysis Report is obtained by multiplying the wage rate times the hours worked by Activity-Item number. Only prime contractor's employees are recorded since the subcontractors are responsible for their own cost control.
13 & 14	Qty. Units	-Material unit costs are keyed internally in the computer to these two items.
15	Act.-Item	-The actual material cost for the Weekly Cost Analysis Report is found by multiplying the unit cost by the quantity of material delivered.
16	P. O. No.	-Purchase order number is used as a cross-check to match the material and cost to the project.
17 & 18	Type Eq. No.	-Hourly equipment rates are keyed internally in the computer to these two items.
19	Hours	-The actual equipment cost for the Weekly Cost Analysis Report is generated by multiplying the hours used by the hourly rate.

UTILIZATION OF INPUT DATA AND PROCEDURES FOR CALCULATING OUTPUT DATA (Continued)

Input		Output/Calculation
*** Daily Report ***		
Item No.	Description	
20 & 21	Idle Maint.	-Used for upper management to monitor equipment utilization.
22 thru 27	Subc. Comment	-Administrative data not entered into the computer, but kept for the record.
*** Weekly Progress Report: ***		
1 thru 3	Project No. Proj. Name	-Administrative data kept on file, but not entered into the computer.
4	Act.-Item	-Percentage completion is needed by Activity-Item number for the Weekly Cost Analysis Report. This will allow the manager to correct the cost overrun Items which have the largest remaining duration.
5	Workdays	-For cases where additional time is required to complete an Item an estimate of the workdays required to finish the work is entered. This will extend the Item duration and possibly require rescheduling.
6	Percent	-When the work is progressing or ahead of schedule an estimate of the percent of work complete for the Item is made. This value is used in the Weekly Cost Analysis Report and also modifies the duration of Items in the Charts of Material

UTILIZATION OF INPUT DATA AND PROCEDURES FOR CALCULATING OUTPUT DATA (Continued)

Input		Output/Calculation
* Weekly Progress Report: *		
Item No.	Description	
6 (Cont.)		Deliveries and Scheduled Work. The length of the bar charts is shortened by the amount of completed work.
7	Remarks	-Administrative data for record purposes.
8 thru 9	Act.-Item	-Same use as items 4, 5, and 6 above except this covers the subcontractors. Most of the subcontract entries will be only Activity numbers since detailed Item numbers are not normally required. Cost analysis is not performed on these items, but they are needed to update the schedule and to verify the subcontractor's invoice.
11	Trade	-Facilitates the verification of the Activity-Item number for updating.
12 & 13	Remarks	-Administrative data not computerized.
* Weekly Salaried Personnel/Support Equipment Report: *		
1 thru 3	Proj. No. Proj. Name	-Administrative data not computerized.
4 & 5	Name	-Pay rates are keyed to these two items by computer. Used to calculate monthly billing. These labor hours are not distributed by Activity-Item number because they are overhead

UTILIZATION OF INPUT DATA AND PROCEDJRES FOR CALCULATING OUTPUT DATA (Continued)

Input		Output/Calculation
* Weekly Salaried Personnel/Support Equipment Report: *		
Item No.	Description	
4 & 5 (Cont)		charges and not direct labor.
6	Hours	-Payroll data not used for scheduling.
7 thru 9	Description Total Hrs.	-Hourly rates are keyed internally in the computer to these two items. Monthly billing is calculated using the product of the hours used times the hourly rate.
* Weekly Purchasing Report: *		
1 thru 3	Project No. Proj. Name	-Administrative data used to identify the proper project.
4	Type	-Not entered into the computer, but used to clarify the manual report.
5	Qty/Units	-Used to revise the estimated quantity.
6	Total cost	-Used to revise the estimated costs for material.
7	Discount	-Used in the accounting system to highlight bills to be paid first.
8	Delivery Date	-If this is not the same as the scheduled date then the schedule will be revised.
9	Purchase Order No.	-Used to cross-check delivery quantities with the original order.
10	Activity-Item No.	-Used to apply the material ordered to the proper Activity-Item in the schedule.

UTILIZATION OF INPUT DATA AND PROCEDURES FOR CALCULATING OUTPUT DATA (Continued)

Input		Output/Calculation
* Weekly Purchasing Report: *		
Item No.	Description	
11 & 12	Company Trade	-Administrative data to clarify the report, and keyed to the trade descriptions in the schedule.
13	Total cost	-Used for accounting not for scheduling.
14	Start Date	-If this date does not comply with the scheduled date, then the schedule will be revised.

APPENDIX F

Simulated Output Reports for SPMS

1. Cover Page
2. Monthly Summary
3. Chart of Scheduled Work
4. Chart of Scheduled Material
5. Trade List of Material and Work
6. Milestones/Logic Diagram
7. Weekly Cost Analysis

DATE OF DATA: 28 MAR 75 ** COVER PAGE ** DATE PRINTED: 30 MAR 75
PROJECT NAME: APPLIED INSTR BLDG CONTR: EIJ CORP PAGE 1 of 10

****

PROJECT LOCATION: STATE COLLEGE PA
OWNER: U. S. NAVY
LATEST CHANGE ORDER PROCESSED: 12
CONTRACT COMPLETION DATE: 10 DEC 75
PROJECTED COMPLETION DATE: 10 FEB 76
CALENDAR DAYS AHEAD (+) OR BEHIND (-) SCHEDULE: -62

** TABLE OF CONTENTS **

REPORT TITLE: PAGE NO.

DATE OF DATA: 28 MAR 75 ** MONTHLY SUMMARY ** DATE PRINTED: 30 MAR 75
PROJECT NAME: APPLIED INSTR BLDG CONTR: EIJ CORP PAGE 2

****

WORK IN PLACE SINCE 28 FEB 75: $88,800
MATERIAL DELIVERED SINCE 28 FEB 75: $60,000
TOTAL PERCENTAGE OF WORK COMPLETE: 45%
TOTAL PAYMENT DUE THIS PERIOD LESS 10% FOR RETENTION: $123,920
TOTAL CONTRACT VALUE THROUGH CHANGE ORDER NO. 12 IS: $4,665,000
PROJECTED PAYMENT FOR NEXT 30 DAY PERIOD LESS 5% FOR RETENTION: $142,987

** TRADE REQUIREMENTS **

TRADE	TOTAL MANDAYS	TRADE REQUIREMENTS FOR NEXT 60 DAYS BY WEEK										
		31/3 +	7/4 +	14/4 +	21/4 +	28/4 +	5/5 +	12/5 +	19/5 +	26/5 +	+	+
GC	250	25	25	25	25	25	25	25	50	25		
EL	10	.	.	.	.	.	.	.	.	10		
HV	12	.	.	.	.	.	.	.	6	6		
LV	2	.	.	.	.	.	.	.	.	2		
ME	120	.	15	15	15	15	15	15	15	15		
PL	X	.	.	.	.	.	.	.	X	X		
ST	50	50										

** EQUIP REQUIREMENTS **

EQUIP. NAME	TOTAL HOURS	MAJOR EQUIPMENT FOR NEXT 60 DAYS BY WEEK										
		31/3 +	7/4 +	14/4 +	21/4 +	28/4 +	5/5 +	12/5 +	19/5 +	26/5 +	+	+
10T CRNE	40	40										
GRADER	24	.	.	24								

```
DATE OF DATA:  28 MAR 75  ** CHART OF SCHEDULED WORK  **  DATE PRINTED:  30 MAR 75
PROJECT NAME:  APPLIED INSTR BLDG.     CONTR:  EIJ CORP                  PAGE:   3
                                                            I#         J#
            *  CRITICAL ACTIVITIES BY EARLY START  *   KEY:  VVVVVVVVVVVV-PLANNED

**********************************************************************************

ACTIVITY DESCP TR DUR. TOTAL TIME SCALE FOR 60 DAYS BY WEEK                   CONT
                             31/3 7/4  14/4 21/4 28/4 5/5  12/5 19/5 26/5
          AREA         SLACK ++++++++++++++++++++++++++++++++++++++++++++++    WDAY
                              .    .    .    .    .    .    .    .    .    .
ERT MTL STAIRS ST 8.0    -41  -654 656                                     +
          EAST                VVV
FIN MTR STAIRS ST 8.0    -41   656  660                                    +
          EAST                 VVVVVVVV
PLACE FLOOR    GC 8.0    -33  -702  704                                    +
          2FLW                VVVVVVVV
UGPIPE PLACED  PL 10.0   -18         750    752                            +
          1FLW                       VVVVVVVVVV
IMBED MECH     ME 5.0    -41            710  712                           +
          2FLE                          VVVVVV
PLACE FLOOR    GC 8.0    -41                 712  714                      +
          2FLE                               VVVVVVVV
IMBED MECH     ME 5.0    -38                 712  716                      +
          3FLW                               VVVVV
BCKFILL GRADE  GC 3.0    -18                   752 754                     +
          1FLW                                 VVV
IMBED MECH     ME 5.0    -18                       754  756                +
          1FLW                                     VVVVV
PLACE FLOOR    GC 8.0    -41                           716  718            +
          3FLW                                         VVVVVVVV
```

```
DATE OF DATA:  28 MAR 75  **  CHART OF SCHEDULED WORK  ** DATE PRINTED:  30 MAR 75
PROJECT NAME:  APPLIED INSTR BLDG     CONTR:  EIJ CORP                     PAGE: 4
                                                                I#       J#
            *  CRITICAL ACTIVITIES BY EARLY START  *   KEY:  VVVVVVVVVV-PLANNED

*************************************************************************************

ACTIVITY DESCP TR DUR. TOTAL     TIME SCALE FOR 60 DAYS BY WEEK                 CONT
                                31/3 7/4  14/4 21/4 28/4 5/5  12/5 19/5 26/5
          AREA          SLACK   +++++++++++++++++++++++++++++++++++++++++++++++  WDAY
                                .    .    .    .    .    .    .    .    .    .
IMBED MECH     ME  5.0   -38                       716 720                 +
          3FLE                                     VVVVV
UGPIPE PLACED  PL 10.0   -37                       760    762              +
          1FLE                                     VVVVVVVVVV
PLACE FLOOR    GC  5.0   -18                         756  758              +
          1FLW                                       VVVVV
PLACE FLOOR    GC  8.0   -41                             720  722          +
          3FLE                                             VVVVVVVV
IMBED MECH     ME  5.0   -38                             720  724          +
          ROFW                                             VVVVV
LAYOUT PARTNS  GC  5.0   -35                             2500 2502         +
          INTR                                             VVVVV
BCKFILL GRADE  GC  3.0   -37                              762 764          +
          1FLE                                              VVV
IMBED MECH     ME  5.0   -37                                 764 766       +
          1FLE                                               VVVVV
ROUGH IN CORD  GC  1.0   -35                                 2502 2510 +
          STAR                                               V
SET MTL FRAMS  GC  6.0   -18                                 2502 2504 +
          STAR                                               VVVVVV
INSTAL STAIRS  GC  8.0   -15                                 2506 2508 +
          STAR                                               VVVVVVVV
```

```
DATE OF DATA:   28 MAR 75  **  CHART OF SCHEDULED WORK  **  DATE PRINTED:  30 MAR 75
PROJECT NAME:   APPLIED INSTR BLDG     CONTR: EIJ CORP                        PAGE: 5
                                                                     I#      J#
            *  CRITICAL ACTIVITIES BY EARLY START  *    KEY:  VVVVVVVVV-PLANNED

*************************************************************************************

ACTIVITY DESCP TR DUR. TOTAL      TIME SCALE FOR 60 DAYS BY WEEK                CONT

         AREA            SLACK  31/3 7/4  14/4 21/4 28/4 5/5  12/5 19/5 26/5
                                ++++++++++++++++++++++++++++++++++++++++++++++  WDAY
                                .    .    .    .    .    .    .    .    .
START ROUGH IN EL  5.0   -18                                       2510  2520+
         WEST                                                        VVVVV
START ROUGH IN PL  5.0   -28                                       2510  2540+
         WEST                                                        VVVVV
START ROUGH IN HV 10.0   -35                                       2510  2560+
         WEST                                                        VVVVVVVVV-   1
PLACE ROOF     GC  8.0   -41                                        724   726+
         WEST                                                          VVVVVVV-   1
IMBED MECH     ME  5.0   -38                                        724   730+
         PENT                                                          VVVVV
DUMMY          ME  0.0   -38                                          730 766+
                                                                           0
```

* NEAR CRITICAL ACTIVITIES BY EARLY START *
(WITHIN 30 DAYS OF CRITICAL PATH)

NONE THIS PERIOD

* OTHER ACTIVITIES BY EARLY START *

NONE THIS PERIOD

```
DATE OF DATA:  28 MAR 75  **  CHART OF SCHEDULED MAT'L  **  DATE PRINTED:  30 MAR 75
PROJECT NAME:  APPLIED INSTR BLDG      CONTR:  EIJ CORP                     Page:   6
                                                                 I#    J#
            *  CRITICAL DELIVERIES BY EARLY START  *      KEY:  VVVVVVV-PLANNED

*************************************************************************************

ACTIVITY DESCP TR DUR. TOTAL      TIME SCALE FOR 60 DAYS BY WEEK                CONT

         TYPE          SLACK     31/3 7/4  14/4 21/4 28/4 5/5  12/5 19/5 26/5
                                 ++++++++++++++++++++++++++++++++++++++++++++++ WDAY
                                 .    .    .    .    .    .    .    .    .    .
AIR CONDITION  HV 70.0    0      -278 280                                     +
         MATL                    VVVVVVVV
COOL TOWER     PL 80.0    0      -272             274                         +
         MATL                    VVVVVVVVVVVVVVVVVV

               *  NEAR CRITICAL DELIVERIES BY EARLY START  *
                    (WITHIN 30 DAYS OF CRITICAL PATH)

DIST PANEL     EL 80.0   13      -254             256                         +
         MATL                    VVVVVVVVVVVVVVVVVV
TRANSFORMER    EL 80.0   13      -260             262                         +
         MATL                    VVVVVVVVVVVVVVVVVV
METERS         EL 80.0   13      -266             268                         +
         MATL                    VVVVVVVVVVVVVVVVVV

               *  OTHER MATERIAL DELIVERIES BY EARLY START  *

ELEVATOR       LV 80.0   35      -248                  250                    +
         MATL                    VVVVVVVVVVVVVVVVVVVVVVV
```

DATE OF DATA: 28 MAR 75 ** TRADE LIST OF MAT'L & WORK ** DATE PRINTED: 30 MAR 75
PROJECT NAME: APPLIED INSTR BLDG CONTR: EIJ CORP PAGE: 7

* RESPONSIBLE TRADE: GC-GENERAL CONTRACTOR *
BY EARLY START DATE

****

CODE I	NO. J	ACTIVITY DESCP	DUR. WDAY	COST $	WORK AREA	EARLY START	EARLY FINISH	TOTAL SLACK
702	704	PLACE FLOOR	8.0	26,000	2FLW	28 MAR 75	9 APR 75	-33

ITEM NO.	ITEM DESCRIPTION	QTY	UNIT	ESTIMATE LABOR HRS	ESTIMATE LABOR COST	ESTIMATE MAT'L COST	ESTIMATE EQUIP COST	UPDATE % COMPL	OR	UPDATE WDAYS REMAINING
1	FORMING	1250	SFCA	50.0	2,000	300	100	______		______
2	POURING	1100	CY	120.0	8,000	12,000	600	______		______
3	STRIPING	1250	SFCA	10.0	2,000	500	500	______		______

CODE I	NO. J	ACTIVITY DESCP	DUR. WDAY	COST $	WORK AREA	EARLY START	EARLY FINISH	TOTAL SLACK
712	714	PLACE FLOOR	8.0	24,000	2FLE	21 APR 75	1 MAY 75	-41

ITEM NO.	ITEM DESCRIPTION	QTY	UNIT	ESTIMATE LABOR HRS	ESTIMATE LABOR COST	ESTIMATE MAT'L COST	ESTIMATE EQUIP COST	UPDATE % COMPL	OR	UPDATE WDAYS REMAINING
1	FORMING	1250	SFCA	50.0	2,000	300	100	______		______
2	REBAR	2	TON	20.0	4,000	3,000	200	______		______
3	POURING	1100	CY	100.0	4,000	9,000	400	______		______
4	STRIPING	1250	SFCA	10.0	2,000	500	500	______		______

NOTE: There are eight more Activities for the General Contractor, but they are not shown in this example.

DATE OF DATA: 28 MAR 75 ** TRADE LIST OF MAT'L & WORK ** DATE PRINTED: 30 MAR 75
PROJECT NAME: APPLIED INSTR BLDG CONTR: EIJ CORP PAGE: 8

* RESPONSIBLE TRADE: EL-ELECTRICIAN *
BY EARLY START DATE

****

CODE NO. I	J	ACTIVITY DESCP	DUR. WDAY	COST $	WORK AREA	EARLY START	EARLY FINISH	TOTAL SLACK
254	256	DIST PANEL	80.0	20,000	MATL	1 JAN 75	23 APR 75	13

ITEM NO.	ITEM DESCRIPTION	QTY	UNIT	ESTIMATE LABOR HRS	ESTIMATE LABOR COST	ESTIMATE MAT'L COST	ESTIMATE EQUIP COST	UPDATE % COMPL	OR	UPDATE WDAYS REMAINING
1	SUBMIT	10	WDAY					______		______
2	APPROVE	10	WDAY					______		______
3	FABRICATE	50	WDAY					______		______
4	DELIVER	8	EACH	5.0	100	16,000	250	______		______

CODE NO. I	J	ACTIVITY DESCP	DUR. WDAY	COST $	WORK AREA	EARLY START	EARLY FINISH	TOTAL SLACK
260	262	TRANSFORMER	80.0	10,000	MATL	1 JAN 75	23 APR 75	13

ITEM NO.	ITEM DESCRIPTION	QTY	UNIT	ESTIMATE LABOR HRS	ESTIMATE LABOR COST	ESTIMATE MAT'L COST	ESTIMATE EQUIP COST	UPDATE % COMPL	OR	UPDATE WDAYS REMAINING
1	SUBMIT	10	WDAY					______		______
2	APPROVE	10	WDAY					______		______
3	FABRICATE	60	WDAY					______		______
4	DELIVER	1	EACH	10.0	200	20,000	600	______		______

CODE NO. I	J	ACTIVITY DESCP	DUR. WDAY	COST $	WORK AREA	EARLY START	EARLY FINISH	TOTAL SLACK
2510	2520	START ROUGH IN	5.0	2,000	WEST	21 MAY 75	28 MAY 75	-18

ITEM NO.	ITEM DESCRIPTION	QTY	UNIT	ESTIMATE LABOR HRS	ESTIMATE LABOR COST	ESTIMATE MAT'L COST	ESTIMATE EQUIP COST	UPDATE % COMPL	OR	UPDATE WDAYS REMAINING
1	1" CONDUIT	500	LF	30.0	400	1,600	0	______		______

DATE OF DATA: 28 MAR 75 ** TRADE LIST OF MAT'L & WORK ** DATE PRINTED: 30 MAR 75
PROJECT NAME: APPLIED INSTR BLDG CONTR: EIJ CORP PAGE: 9

* RESPONSIBLE TRADE: HV-HEATING/VENTILATING *
BY EARLY START DATE

****

CODE NO. I J	ACTIVITY DESCP	DURING WDAY	COST $	WORK AREA	EARLY START	EARLY FINISH	TOTAL SLACK

NOTE: This report follows the same form as the Electrician's. Separate listings are made for the Elevator; Mechanical; Plumbing; and structural subcontractors.

```
DATE OF DATA:  28 MAR 75  **  MILESTONES/LOGIC DIAGRAM  **  DATE PRINTED:  30 MAR 75
PROJECT NAME:  APPLIED INSTR BLDG     CONTR:  EIJ CORP                      PAGE:  10

                  *  ACTIVITIES RANKED BY EARLY START  *

**************************************************************************************

        ACTIVITY                              TIME SCALE IN MONTHS

CODE NO.   DESCRIPTION

 I     J                      + 3/75 4/75 +5/75 +6/75 +7/75 +8/75 +9/75 +10/75 +11/75+

1001 1002  EXCAV COMPL         X
2001 2002  STRUCTURE COMP                                      X
3001 3002  CLOSE IN EXTER                                                         X
3501 3502  START FINISH TR                                                           X
```

DATE OF DATA: 28 MAR 75 ** WEEKLY COST ANALYSIS ** DATE PRINTED: 30 MAR 75
PROJECT NAME: APPLIED INSTR BLDG CONTR: EIJ CORP PAGE: 1 of 1
PROJECT LOCATION: STATE COLL PA OWNER: U. S. NAVY
REPORT FOR PERIOD FROM 24 MAR 75 to 28 MAR 75

* OVERRUN ITEMS * (5% OR MORE OVER COST)

****

ACTIVITY			ITEM		ACTUAL COST OVER			INDICATED	
CODE I	NO. J	DESCRIPTION AREA	NO. DESCRIPTION	% COM	ESTIMATED COST LABOR	MAT'L	EQUIP	% OVER	OUTCOME
702	704	PLACE FLOOR	2 POURING	80	9,800	10,000	400	23	-939
		2FLW			8,000	12,000	600		

* UNDERCOST ITEMS * (5% OR MORE UNDER COST)

ACTIVITY					ACTUAL COST OVER			INDICATED	
CODE I	NO. J	DESCRIPTION AREA	NO. DESCRIPTION	% COM	ESTIMATED COST LABOR	MAT'L	EQUIP	% OVER	OUTCOME
752	754	BCKFILL GRADE	1 SELCT FILL	30	1,000	2,000	1,000	41	+12,950
		1FLW			9,000	18,800	4,000		

APPENDIX G

Simulated Input Reports for SPMS

1. Superintendent's Daily Report

2. Superintendent's Weekly Progress Report

3. Weekly Salaried Personnel/Support Equipment Report

4. Weekly Purchasing Report

1-74	EIJ CORPORATION	324
PROJECT NO.		REPORT NO.

SUPERINTENDENT'S DAILY REPORT

4 Apr 75
DATE

Applied Instr, S.C., Pa.
PROJ. NAME & LOCATION

Cloudy-Rain
WEATHER

65 :8AM 85 :4PM
TEMPERATURE

A. EIJ LABOR: (HOURLY ONLY) HOURS USED BY ACTIVITY-ITEM #

	EMPLOYEE NAME	BADGE NO.	CLASS	702-704-1	702-704-2				REMARKS*
1.	P. Smith	585555989	Fore	6	4*				Late Pour
2.	A. Jones	767885989	Carp	6	4*				Late Pour
3.	R. Green	456637876	Carp	6	4*				Late Pour
4.	D. Brown	344567070	Carp	6	4*				"
5.	E. Hunt	342567898	Fore	4	4				
6.	G. Liddy	678987089	Labr	8					
7.	H. Hughes	675465789	Labr	8					
8.	R. Dixon	123543211	Labr		8				
9.									
10.									
11.									
12.									
13.									
14.									
15.									
16.									
17.									
18.									
19.									
20.									

AN (*) DENOTES OVERTIME

B. EIJ MATERIAL DELIVERED: (ATTACH DELIVERY RECEIPTS)

	DESCRIPTION	QTY	UNIT	ACTIVITY-ITEM #	P. O. NUMBER
1.	3/4" Plywood	1,000	SF	702-704-1	1-74-0034
2.	Conc. Mix 213	60	CY	702-704-2	1-74-0040
3.					
4.					
5.					
6.					
7.					
8.					
9.					

C. EIJ EQUIPMENT: HOURS USED BY ACTIVITY-ITEM #

TYPE	EQUP. #	702-704-2						IDLE	MAINT.
1. Conc. Pump	99-098	5						5	
2.									
3.									
4.									
5.									
6.									
7.									
8.									
9.									

D. SUBCONTRACTORS WORK:

COMPANY NAME	TRADE	MEN	WORK PERFORMED
1. EZ Steel	ST	10	Cont. finish work on stairs
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

E. TESTS PERFORMED/RESULTS:

1. 10 Concrete cylinders taken from pour today.
2.
3.
4.
5.
6.

F. COMMENTS: (VISITORS, ACCIDENTS, VERBAL DIRECTIONS, ETC.)

Navy Inspector - Mr. Bullhead on site for pour

George Shaky

SUPERINTENDENT'S SIGNATURE

1-74 PROJECT NO.	EIJ CORPORATION	4 /Apr / 75 WEEK ENDING

WEEKLY PROGRESS REPORT BY SUPT.

Applied Instr. S.C., Pa.
PROJECT NAME & LOCATION

NOTE: A COPY OF THE "LIST OF MAT'L AND WORK REPORT" MAY BE ATTACHED IF UPDATE DATA IS MARKED IN RED.

A. EIJ WORK ACCOMPLISHED:

	ACTIVITY-ITEM	WORK DAYS REMAINING	OR	PERCENT COMPLETE	REMARKS*
1.	702-704-1			100	
2.	701-704-2			50	
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					

*DESCRIBE ANY MAJOR DEVIATIONS FROM THE SCHEDULE, OTHERWISE USE THE COMPUTER PRINTOUT FOR THIS SECTION.

B. SUBCONTRACTOR WORK ACCOMPLISHED:

	ACTIVITY-ITEM	WORK DAYS REMAINING	OR	PERCENT COMPLETE	TRADE	REMARKS*
1.	656-660	5			ST	Rain delay 2 days
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						
10.						
11.						
12.						
13.						
14.						
15.						
16.						
17.						
18.						
19.						
20.						
21.						
22.						
23.						
24.						
25.						

C. COMMENTS:

Have tried to contact Plumber but no response to date.

George Shaky
SUPERINTENDENT'S SIGNATURE

1-74	EIJ CORPORATION	4 /Apr/74
PROJECT NO.		DATE

WEEKLY SALARIED PERSONNEL/SUPPORT EQUIPMENT REPORT

Applied Instr. S.C., Pa.
PROJECT NAME & LOCATION

A. EIJ PERSONNEL: (SALARIED ONLY)

NAME	TITLE	HOURS* M	T	W	TH	F	S	S
1. G. Shakey	Supt.	8	8	8	8	8		
2. B. Shakey	Asst. Supt.	4S	8	8	8	4A		
3. I. L. Duce	Timekeeper	4S	8	8	8	4A		
4. J. Smith	Engineer	8	8	8	8	8		
5.								
6.								
7.								
8.								
9.								
10.								

* H-HOLIDAY: S-SICK: A-ANNUAL LEAVE: U-UNACCOUNTED ABSENT

B. EIJ SUPPORT EQUIPMENT: (OFFICE TRAILERS, ETC.)

DESCRIPTION	EQUIP. #	TOTAL HOURS ON SITE
1. Office Trailer	99-006	40
2. Storage Trailer	99-089	40
3.		
4.		
5.		

George Shakey
SUPERINTENDENT'S SIGNATURE

1-74
PROJECT NO.

EIJ CORPORATION

WEEKLY PURCHASING REPORT

4 /Apr/74
WEEK ENDING

Applied Instr. S. C., Pa.
PROJECT NAME & LOCATION

A. MATERIAL ORDERED:

TYPE	QTY. UNITS	TOT. COST UNIT COST	DIS.	DEL. DATE	P. O. NO.	ACTIVITY-ITEM NO.
1. Concrete Mix 213	120 CY	12,000 100	10% 30D	3 May 75	0089	716-718 3
2. Select Fill	1,000 CY	10,000 10	5% 10D	23 Apr 75	0090	752-754 2
3.						
4.						
5.						
6.						
7.						
8.						
9.						
10.						
11.						
12.						
13.						
14.						
15.						
16.						
17.						
18.						
19.						
20.						
21.						
22.						
23.						
24.						
25.						

B. SUBCONTRACTS AWARDED:

	COMPANY NAME	TRADE	TOTAL COST	START DATE
1.	Ready Flow Paint	PA	23,567	5 Oct 75
2.	Shagg Carpet Co.	CA	44,989	10 Oct 76
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

C. COMMENTS:

All subcontracts have been awarded except the landscaping.

Jack Cash

PURCHASING AGENT

Thesis 166516
B809237 Bromilow
c.1
A construction Superintendent's project monitoring system.